THE ART of SHADOWS: OR, Universal-Dialling;

WITH

TABLES exactly *Calculated* for the *Lat.* of 51 deg. 30 min. *viz.* London.

Teaching any *Perſon*, tho' of an ordinary *Capacity*, and unlearned in the Mathematicks, to draw a true SUN-DIAL, upon any given PLAN, however *Situated*, in reſpect of *Declination* and *Reclination*.

AND

A TABLE ſhewing the Diſtance of each *Hour-Line* from the *Meridian*, upon all *Horizontal-Dials*.

LIKEWISE,

ARITHMETICAL, } INSTRUMENTAL,
SPOT, CONCAVE, } REFLEX,
CONVEX, } CYLINDRICAL

DIALLING.

WITH

the manner of *Ornamenting* theſe ſeveral ſorts of *Dialling* with all Uſeful *Furniture*; and how to Cut the *five Regular Bodies*, and two others, one of twelve *Rhombs*, and the other of thirty.

The Second Edition, with Additions.

By *JOHN GOOD*, Teacher of Mathematicks.

LONDON:
Printed and Sold by *J. Robinſon*, in St. *Paul's Church-Yard*: R. *Mount*, on *Tower-Hill*: *J. Taylor*, in *Pater-Noſter-Row*: And at the Author's-Houſe in *Seething-Lane*. 1711.

Enter'd in the Hall-Book, April *the 7th*, 1711.

MVSEVM
BRITANNICVM

TO THE READER.

THIS *Treatiſe of* Dialling *conſiſteth, as before, of* Geometrical *and* Inſtrumental Dialling: *And the Acceptance it hath found among the Ingenious, hath Encouraged me to add a Third Part, namely, an* Arithmetical *way by the Canons of Artificial Sines aud Tangents: And there are in it, as before, the Tables of Hour-diſtances of all declining Dials, from one deg. of Declination to* 60 *deg. which I have Calculated my ſelf, and I think they are very exactly done, ſo that you may depend upon them. The Inſtruments by which Dialling may be performed are many, but amongſt them all I think I have made choice of the Beſt, namely, a Ruler, accommodated with Scales and Lines neceſſary for that purpoſe.*

The Firſt *Scale, is a Scale of Hours, each Hour divided as the bigneſs of the Scale will permit, being proper for all Dials that have no Declination, as the Horizontal, the Di*rect South *and* North, *whether Upright or Reclining, except the Stiles height be leſs than* 10 *deg. When that happens, there are other Scales for that purpoſe; and this Scale hath the Letters (Hours) at the beginning.*

The Second *Scale, is a Scale of* 90 *deg. anſwerable to the Scale of Hours, and may be divided as the length of the Scale will give leave: This Scale and the firſt, will together ſhew how many deg. and min. of the Equinoctial under,* &c.

The Third *Scale, is a Scale of Latitude, known by the Letters (Lat.) at the beginning.*

The Fourth *and* Fifth *Scales, are two Scales of Hours of a different length, either of them will ſerve to make* Eaſt Weſt, *Equinoctial, and Equinoctial declining Dials.*

Both theſe Scales together, ſerve to draw all ſuch Dials, whoſe Stile is but of ſmall Elevation, and the Centre of the Dial is left out, and are known by the Letters (G. Pol.) *and* (L. Pol.) *at the beginning.*

It is proper to have two or three Lines of Chirds (upon your Ruler) of ſeveral Raduſes, and ſo have you a compleat Ruler.

And therefore if any Perſon be delighled with Recreation of this Nature, and hath not much Time to ſpend, they are here fitted with an Inſtrument which will diſpatch preſently and perform it exactly; they need not to fear to looſe themſelves in a Wilderneſs of Lines, nor out run the limits of the Plane, by infinite Excurſion (two inconveniencies which the common way of Geometrical Dialling *is ſubject to) they are here acquitted of both, having nothing to do but to draw the* Dial *it ſelf, contracted within the limits of the Plane. If any want Skill in the* Mathematicks *let them not deterr from this Subject, for there is little required of them. If ſome think the Canon more exact, ſo do I, but not ſo eaſy to be underſtood, nor ſo ready in uſe, nor ſo ſpeedy in performance, nor truly ſo well fitting the Capacities of all Perſons. I ſhall ſay nothing in Commendation of this Book, hoping it will ſpeak for it ſelf, I remain a Well-wiſher to the* Mathematicks,

JOHN GOOD.

To the AUTHOR, *on his Ingenious* BOOK; Intituled, *The* ART OF SHADOWS: Or; UNIVERSAL DIALLING.

I.

DOes Time (*ſub Deo*) *nolens volens* Rule
The Univerſe with uncontrolled Sway?
Do both Nature and Art, Wiſeman and Fool,
His Law of Limit, all alike Obey?
Do all viſible things on Time depend;
In Time Begin, Perfect, and make their End?

II.

Does every Orb of each denomination,
Whether the fixed Orbs or Wanderers,
Keep Time's unbroken Law of Limitation:
By *Minutes*, *Hours*, *Days*, *Weeks*, *Months* & *Years*?
Does Time's Progreſs admit of no Ceſſation,
'Till Eternity ſtop his Numeration?

III.

Is Time that's paſt beyond retrievement loſt,
Impoſſible to be reſtor'd again?
Does time that's preſent fly more ſwift than Poſt,
And ne'er one Moment, in one ſtay remain?
Can nothing ſtop Time's Feet, none hold his Wings,
Empires nor Emp'rors, Kingdoms nor their Kings?

IV.

Can neither Strength, Power, nor Policy?
Can neither Wiſdom, Learning, Wit nor Art,
Riches, Grandeur, Honour, nor Majeſty,
Stop Time's fleet Pace, or his Progreſs revert;
Nor Favour, nor Intereſt, nor Bribery
Stay Time's ſwift Paſſage to Eternity?

Does

V.

Does Time more ſwift than *Thought* or *Fancy* run;
Yet ſo, that he doth a fit Seaſon lend
To ev'ry Purpoſe underneath the Sun
For to Begin, Perfect, and make its End?
Does Time rule all things, yet all things Obey
That will accept his *S*ervice, while they may?

VI.

If then, Time be the Beſt Thing we Enjoy
Of all *Sub-lunar* Bleſſings we receive;
And greateſt Wiſdom be, Time well t'Imploy;
Which being loſt, we never can retrieve:
Sure from theſe Premiſes, I may inferr,
To watch Time's Paſſage, ſhould be our *chief care*.

VII.

If ſo, then ſure I may, (without denial)
Affirm that the moſt Uſeful Art, which by
The *Art* of *Shadows*, or a *True made Dial*,
From the Sun's bright Reflection, to each Eye,
Doth ſhew us how, (by eaſy definition)
This ſwift Accomptant, ſums up his Addition.

VIII.

Then ſure above all, that e're writ the Art,
For Plainneſs, Fulneſs, Shortneſs, and Perfection,
GOOD doth this Univerſal Good impart,
To all Capacities, by his Direction:
For, both by Inſtruments, and Calculation,
GOOD above all, makes good his Application.

W^m. BRITTAIN, *Philomath.*

Taught the following Mathematical Sciences,

By the AUTHOR, *viz.*

Writing,
Geometry,
Trigonometry,
Aſtronomy,
Geography,
Arithmetick,
Dialling,
Navigation,
Meaſuring,
Surveying,
Gauging,

Alſo the Uſe of the Globes and Maps, after an *eaſy Method.* Likewiſe *Land* Surveyed, and *Maps* drawn of the ſame.

And Sun-Dials made of what kind ſoever, either *Direct*, *Declining*, *Reclining*, *Inclining*, *Convex* or *Reflex*.

Alſo, the five regular Platonical-Bodies, cut in *Wood*, and adorn'd with variety of *Sun-Dials*; being *Proper* and *Ornamental* for *Gentlemens Gardens*.

Perſons Taught Abroad. By *JOHN GOOD*.

At the Old *Mathematical*-Shop, the *Croſs-Daggers* in *Moore-Fields*, are Made and Sold by *E. CULPEPER*.

ALL ſorts of Mathematical-Inſtruments in *Silver*, *Braſs*, *Ivory*, and *Wood*, accurately Divided, and Uſefull for *Sea* and *Land*; with *Books* of the Uſe of them.

Large *Braſs-Horizontal-Dials*, *Univerſal-Dials*, for the Pocket; all ſorts of *Rules* and *Compaſſes*; *Load-ſtones* ſet in *Gold* and *Silver*, &c.

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Long Teleſcopes, others for the Pocket neatly fitted up with *Silver* and *Braſs* ſlyding-Heads: True-ground *Spectacles*, made of the *Cleareſt-Glaſs*, Approved of by the moſt Skillful in *Opticks*; with all ſorts of *Reading* and *Burning Glaſſes*, *PerſpectiveGlaſſes*, *Priſms*, &c. All Sold at Reaſonable Rates.

SUBSCRIBERS Names TO THE ART of SHADOWS.

Robert Arnold, School-Maſter.
William Barker, Mathematical Inſtrument maker.
Martin Bendall.
Edmund Culpeper, Mathematical-Inſtrument maker.
John Cogg,
Terryl Dalton, Eſq; of *Cambridgſhire.*
Philip Freeman.
Samuel Griſold, Seignior, } Painters.
Samuel Griſold, Junior, }
William Heſter,
Nathanael Hunton, Painter.
Thomas How,
Iſaac Knight, School-maſter.
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Richard Sanders, Mathematical-Inſtrument maker.
Nathanael Smith, Mathematical-Inſtrument maker.
Thomas Warren, School-maſter.
Samuel Wright, School-maſter.
Robert Whitehand,
John Whitehand,

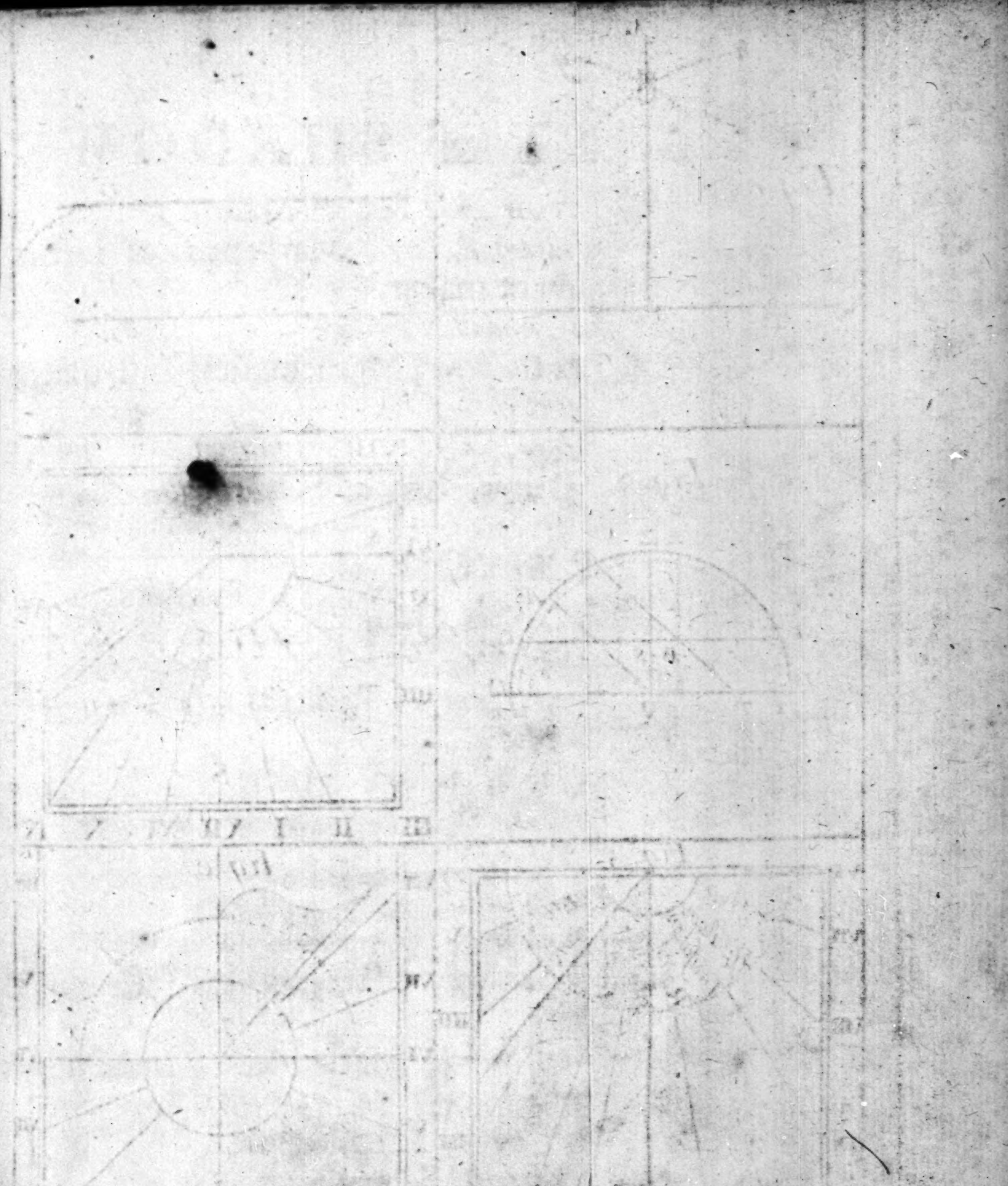
I
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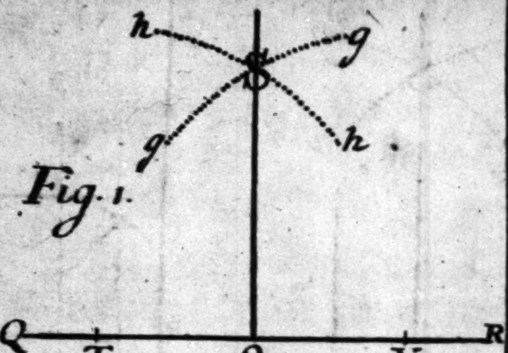
Fig. 1.



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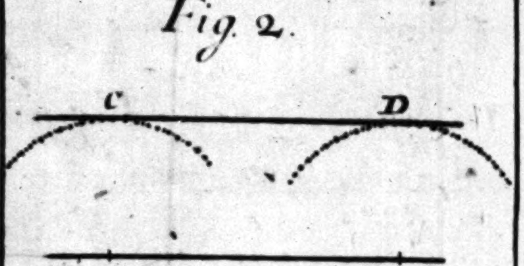

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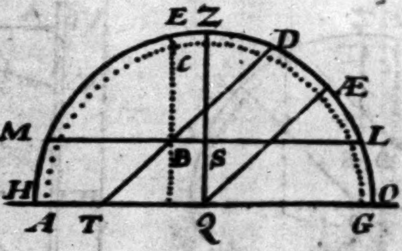

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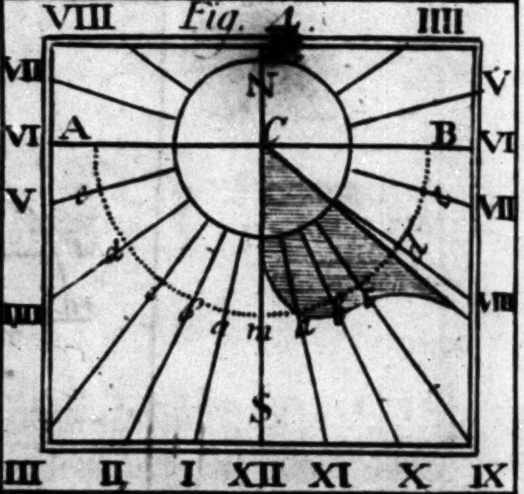

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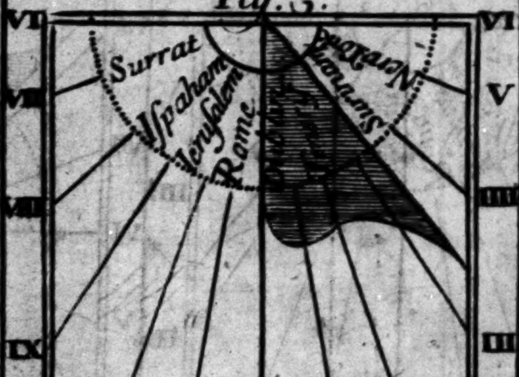

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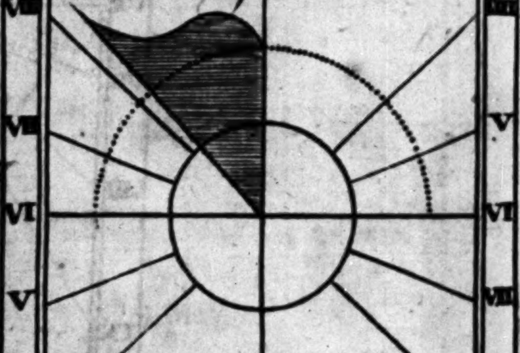


A Neceſſary
INTRODUCTION;
Conſiſting of
Problems and **Definitions**,
Geometrical and *Aſtronomical*:

FOR THE

More eaſy apprehending, and ready Performing of the ſeveral Matters and Things contain'd in the following TREATISE.

Prob. I. Fig. I.

Upon any Point (*as* O) *taken in the Right-Line* QR, *to erect a Perpendicular* OS.

OPEN your Compaſſes to any ſmall Diſtance; and ſetting one Foot in the given Point O, with the other Foot makes Marks on both the ſides O, as at T and V.

2. Open the Compaſſes to any Diſtance, grea- r than the former, and ſetting one Foot in T, ith the other deſcribe the Arch *bb*: Alſo, with e ſame Diſtance, ſet one Foot in V, and with

the other deſcribe the Arch *gg*, croſſing the former Arch *hh* in the Point S.

3. Draw the Line OS, and it will be *Perpendicular* to the given Line QR.

PROB. II. FIG. II.

A Right-Line given, how to draw another Right-Line, which ſhall be Parallel thereunto at any Diſtance required.

LET the Line given be AB, unto which is required to draw another Right-Line CD, which ſhall be Parallel to the former Line AB, and at the Diſtance AC.

1. Open your Compaſſes to the Diſtance AC, then ſet one Foot in the Point A, with the other deſcribe the Arch C; Again, place one Foot in B, and with the other deſcribe the Arch D; then draw the Line CD ſo that it may only touch the two Arches C and D, ſo ſhall the Line CD ſo drawn, be Parallel to AB, and at the Diſtance required.

Aſtronomical Definitions.

1. THE Horizon is that part of the Heavens as a quick Eye can diſcern in an open Place; which divides the Heavens into two equal Parts. The middle Point of the Heavens which is over our Heads, is called the *Zenith*; and that under our Feet the *Nadir*.

2. The *Meridian* is a great Circle of the Heavens, paſſing through the Poles, the *Zenith* and *Nadir*, in which the Sun is at Noon, and at Twelve a Clock at Night.

3. The *Equinoctial* is a great Circle of the Heavens, dividing it into the Northern and Southern Hemiſpheres; and takes their Names from the two Poles, that beiug call'd the *Northern Hemiſphere*, in which the *North-Pole* is ſeated, and that the *Southern* in which the *South-Pole* is ſeated. Unto this Circle when the Sun in his Annual Motion arriveth, (which is twice a Year) the Days and Nights are of an equal length through the whole World.

This Circle cutteth the *Axis* of the World at Right Angles, and is ſeated in the Heavens every ways 90 deg. diſtant from either of the *Poles*.

4. The two Topicks are *Smaller Circles* of the *Heavens*, deſcribed parallel to the *Equinoctial Circle*, and at 23 deg. 30 min. diſtance therefrom; that being the greateſt *Declination* that the Sun hath from the *Equinoctial* towards either of the *Poles*. Of theſe Circles one is called the *Tropick of Cancer*, or Nothern Tropick; the other the *Tropick of Capricorn*, or Southern Tropick. Theſe two Circles are the Bounds or Limits of the Sun's Courſe, for between them he always moveth, never going more Northward or Southward, (that is, declines not nearer to any of the Poles) than 23 deg. 30 min. Wherefore, when the Sun in his, Annual Motion, ſhall arrive to the *Tropick of Cancer*, which is about the 10th or 11th of *June* he maketh the longeſt *Days* to all inhabit the Northern Hemiſphere. And when he arriveth to

the *Tropick of Capicorn*, which is about the 11th of *December*, he maketh the ſhorteſt *Days* to thoſe that inhabit the Northern, and the longeſt to thoſe of the Southern Hemiſphere.

How to find a True Meridian line; *and the* Azimuth *of the* Sun.

IT is very neceſſary to have a true *Meridian-line*, which may be obtained many ways, but the beſt I know for Practice is this;

Get a plain thick Board of a Foot Square, or more, then in the middle, or as near as may be, faſten a ſtrong Iron Pin, about three Inches long, and make it ſo faſt, that it will not ſhake or yield in the leaſt: It matters not whether it be exactly Perpendicular, or not.

Set this Board Horizontally, with Earth or Sand upon the Ground; about Nine a Clock ſee where the Head of this Iron-pin (which muſt be ſharp at top) giveth its Shadow upon the Board, mark that Place: Then take a wooden Ruler, ſharp alſo at the end, and lay it ſo, upon the ſharp end of the Iron-Pin, that the ſharp end of the Ruler, may touch the Mark, then carrying it ſteady, deſcribe a Circle.

Come again about Three a Clock in the Afternoon, and mark where the Shadow of the Top of the Iron-Pin is in that Circle again.

Draw a Line from thoſe two Marks, which will be *Eaſt* and *Weſt*, and the Perpendicular to that Line will be a true Meridian-Line.

Bu

But becauſe the Sun may be under a Cloud, when you come at Three a Clock, you may make three or four more Circles, and uſe them as you uſed this.

When you have a True *Meridian-line*, you will eaſily find the Sun's *Azimuth*, or Diſtance from the *South*; for dold but up a Plumb-line, and the Angle which the Shadow maketh with the *Meridian Line*r is the *Azimuth*; or you may lay the Edge of your *Quadrant* to the *Meridian-Line*, and the Shadow of the Plumb-line paſſing through the Center, will give you the *Azimuth* in the Limb, and better than if you Calculated it by the Sun's *Altitude*.

How to make a Line of Chords to any Length or Radius.

FIrſt make a Right-Line of any Length as CBD, and upon the middle, by the firſt Problem, erect the Perpendicular A B.

Secondly, Open your Compaſſes to the Radius, or Length, that you would have your Line of Chords to be of, which ſuppoſe A B, and with that diſtance upon B, deſcribe the Semicircle C A D.

Thirdly, Your Compaſſes being open to the ſame diſtance you deſcrib'd the Semicircle, ſet one Foot in D, and make a mark in the Quadrant D A, as at R, then take with Compaſſes the diſtance on the Quadrant, from A to R, and ſet from R to S, ſo the Quadrant will be divided into 30, 60, 90 deg. then divide D S, and S R, and *R* A, each into three Parts, which will be 10, 20, 30, 40, 50, 60, 70, 80 and 90.

Laſtly, Set your Compaſſes in D, and open them to every one of the Nine Parts that the Quadrant is divided into by 10, 20, *&c.* and deſcribe the prick'd Line as you ſee in the Figure.

Note : You may divide the Quadrant AD, if you will, into 90 equal Parts, if your Quadrant is large, and ſo transfer them from the Quadrant to the Line CBD, as you did by every ten Degrees.

PROB. III. FIG. III.

The Latitude of the Place, the Declination of the Sun, and the Altitude of the Sun being given, to find the Azimuth, Geometrically.

	deg.	min.	
The Latitude of the Place is	51	30	North.
The Declination of the Sun is	20	9	
The Altitude of the Sun is	18	2	

I. Upon the Center Q, deſcribe the Semicircle HZO for half the Meridian, and upon Q, raiſe the Perpendicular QZ, for the Zenith.

II. Set 51 deg. 30 min. of your Line of Chords, which is the Latitude of *London*, from Z to Æ, and draw ÆQ from the Equinoctial.

III. Set 20 deg. 9 min. the Sun's Declination, from Æ towards Z, to the Point D, (being it is North) and draw the Line DT parallel to ÆQ, ſo is DBT the *Parallel* of the *Sun's Declination.*

IV. Set 18 deg. 2 min. the Sun's Altitude given, from O to L, and from H to M, and draw the Line ML, for the *Parallel* of *Altitude.*

V. Take in your Compaſſes, half the length of the *Parallel* of *Altitude* SL, or SM; and with that Diſtance upon Q, deſcribe the innermoſt Semicircle ACG.

VI. From the Point B, which is where the *Parallel* of *Declination*, and the *Parallel* of *Altitude* do interſect, erect the *Perpendicular* BC, till it touch the innermoſt Semicircle.

VII. Lay a Ruler from Q to C, and it will cut the outermoſt Circle in E; ſo HE meaſured upon a Line of Chords be 80 deg. the Sun's *Azimuth* from the *North* part of the *Meridian*.

VIII. EZ ſhall be 10 deg. the *Azimuth* from the *Eaſt* or *Weſt*.

IX. *Laſtly*, EO ſhall be 100 deg. the *Azimuth* from the *South* part of the *Meridian*.

Note : And whereas throughout this *Book* there is continual mention made of *Degrees* and *Minutes*; know, that a *Degree* is the 360th part of any *Circle*, each of which *Degrees* is ſuppoſed to be divided into 60 Parts called Minutes, ſo that 45 Min. is three quarters of a *Degree*, 30 Min. half a *Degree*, and 15 Min. one quarter of a *Degree*, &c.

A Table of the Sun's Declination.

Days	*January*		*Februa.*		*March*		*April.*		*May.*		*June.*	
	d.	m.	d.	m	d.	m.	d.	m.	d.	m.	d.	m
1	21	44	33	46	3	24	8	36	18	5	23	12
2	21	33	13	26	3	0	8	58	18	20	23	16
3	21	23	13	5	2	37	9	20	18	35	23	19
4	21	13	12	45	2	13	9	42	18	50	23	22
5	21	2	12	25	1	49	10	3	19	4	23	25
6	20	50	12	3	1	25	10	24	19	18	23	27
7	20	38	11	43	1	1	10	45	19	31	23	29
8	20	26	11	21	0	38	11	0	19	44	23	30
9	20	13	11	0	0	14	11	27	19	57	23	31
10	20	0	10	38	0	10	11	47	20	10	23	32
11	19	46	10	16	0	33	12	7	20	22	23	31
12	19	32	9	54	0	57	12	28	20	34	23	31
13	19	18	9	32	1	21	12	48	20	45	23	30
14	19	3	9	10	1	44	13	7	20	56	23	29
15	18	48	8	48	2	8	13	27	21	7	23	28
16	18	32	8	25	2	31	13	46	21	17	23	26
17	18	17	8	3	2	54	14	5	21	27	23	23
18	18	2	7	40	3	18	14	24	21	37	23	20
19	17	45	7	17	3	41	14	42	21	46	23	17
20	17	28	6	54	4	5	15	1	21	55	23	14
21	17	11	6	31	4	28	15	19	22	4	23	10
22	16	54	6	8	4	51	15	37	22	12	23	6
23	16	36	5	45	5	14	15	54	22	20	23	1
24	16	18	5	21	5	37	16	12	22	27	22	55
25	16	0	4	58	6	0	16	29	22	34	22	50
26	15	42	4	34	6	22	16	46	22	41	22	44
27	15	23	4	11	6	45	17	2	22	47	22	37
28	15	4	3	47	7	7	17	18	22	53	22	31
29	14	45	3	39	7	30	17	34	22	59	22	23
30	14	26			7	52	17	50	23	3	22	16
31	84	6			8	14			23	8		

South. | North.

A Table of the Sun's Declination.

Days.	*July.* d.	m.	*August.* d.	m.	*Septem.* d.	m.	*October.* d.	m.	*Novem.* d.	m.	*Decemb.* d.	m.
1	22	8	15	12	4	24	7	15	17	40	23	9
2	22	0	14	55	4	2	7	38	17	56	23	13
3	21	51	14	36	3	38	8	0	18	12	23	17
4	21	42	14	17	3	15	8	22	18	28	23	20
5	21	32	13	58	2	52	8	45	18	43	23	23
6	21	22	13	39	2	29	9	7	18	58	23	26
7	21	12	13	20	2	5	9	29	19	13	23	28
8	21	2	13	1	1 North.	42	9	51	19	27	23	30
9	20	51	12	41	1	19	10	13	19	41	23	31
10	20	40	12	21	0	55	10	33	19	55	23	31
11	20	28	12	1	0	32	10	56	20	8	23	31
12	20	16	11	41	0 South.	8	11	18	20	21	23	31
13	20	4	11	21	0	16	11	39	20	34	23	29
14	19	51	11	0	0	39	12	0	20	46	23	27
15	19	38	10	39	1	3	12	21	20	58	23	25
16	19	25	10	18	1	26	12	41	21	9	23	22
17	19	12	9	57	1	50	13	2	21	20	23	19
18	18	58	9	36	2	13	13	22	21	31	23	16
19	18	43	9	15	2	37	13	42	21	41	23	12
20	18	23	8	53	3	0	14	2	21	50	23	7
21	18	14	8	31	3	25	14	21	22	0	23	2
22	17	59	8	9	3	47	14	41	22	9	23	0
23	17	44	7	47	4	10	15	0	22	15	22	57
24	17	28	7	25	4	33	15	19	22	17	22	51
25	17	12	7	3	4	57	15	37	22	33	22	44
26	16	56	6	41	5	20	15	55	22	40	22	27
27	16	39	6	18	5	46	16	1	22	46	22	30
28	16	22	5	56	6	6	16	3	22	52	22	22
29	16	6	5	33	6	29	16	49	22	58	22	15
30	15	48	5	10	6	52	17	6	23	4	22	5
31	15	30	4	47			17	28			22	56

The End of the Introduction.

How to find the Situation of any Plane, from the South *or* North, *towards either* Eaſt *or* Weſt; *commonly called the Declination of a Plane.*

THE *Declination of a Plane*, is an Arch of the *Horizon* comprehended between the *Pole of the Plane*, and the *Meridian of the Place.* Or it is the diſtance of the *Plane it ſelf*, from the prime *Vertical Circle*, or *Azimuth* of *Eaſt* and *Weſt.*

To find out the *Declination of any Plane*, there are required two Obſervations to be made by the *Sun* at the ſame inſtant of time. The firſt of the *Sun's Horizontal diſtance from the Pole of the Plane*, and Secondly, *of the Altitude of the Sun.*

Firſt, to find the *Sun's Horizontal Diſtance from the Pole of the Plane*. Apply one edge of a Quadrant, to the *Horizontal-Line* of your Plane, ſo that the other may be Perpendicular to it, and the Limb of the Quadrant muſt be towards the *Sun*, and hold the whole *Quadrant Horizontal* as near as you can conjecture: Then holding up a Thread and Plummet, at full Liberty, ſo that the Shadow of the Thread, may paſs both thro' the Center and Limb of the Quadrant, obſerve then the Degrees cut by the Shadow of the Thread, and number them from that ſide of the Quadrant that ſtandeth ſquare or Perpendicular to the Plane: For thoſe Degrees are the *Horizontal Diſtance* required.

Secondly, This *Horizontal Diſtance* and the *Sun's Altitude* being obſerved at the ſame time (as near as may be) will help you to the *Planes Declination* in this manner.

When you make your Obſervation, of the *Sun's Horizontal Diſtance*, mark whether the Shadow of the Thread, fall between the *South*, and that ſide of the Quadrant which is Perpendicular to the Plane.

I. If the Shadow fall between them, the *Azimuth* and *Diſtance* added together, do make the *Declination of the Plane*, and in this Caſe the *Declination* is upon the *ſame Coaſt* whereon the *Sun's Azimuth* is.

II. If the Shadow fall not between them, ſubſtract the leſſer of them from the greater, and the remainder ſhall be the *Plane's Declination*; and if the *Azimuth* be the greater of the two, the Plane Declines to the ſame Coaſt whereon the Sun is; but if the *Diſtance* be the greater, then the Plane Declines to the contrary Coaſt.

And here Note, that the Declination thus found is always accounted from the *South*, and that all Declinations are counted from either *South* or *North*, towards either *Eaſt* or *Weſt*, and muſt never exceed 90 Degrees.

I. If therefore the degrees of Declination do exceed 90, you muſt take the reſidue of that Number to 180, and that ſhall be the *Plane's Declination* from the *North*

II. If the Degrees of *Declination* exceed 180 deg. then the exceſs above 180 deg. gives the *Plane's Declination* from the *North* towards the *Coaſt*, which is contrary to the *Coaſt* whereon the Sun is.

But ſeeing the *Declination* is the Angle contained between the Perpendicular from the *Wall* and the *Meridian*, it may be the beſt to wait in fair Weather, till you find the *Sun* in the *Meridian*; and then the Angle upon the Limb of the Quadrant, will it ſelf be the *Declination*.

A

Deſcription of Dialling.

DIALLING is an Art teaching how to Meaſure the time of the *Day*, by the ſhade of the *Sun*; and originally is a *Mathematical Science*, attained by the Philoſophical contemplation of the motion of the *Sun*, the motion of the *Shadow*, the Conſtitution of the *Sphere*, the Situation of *Planes*, and the conſideration of *Lines*.

The motion of the *Sun* is regular, it moving equal Space in equal Time; but the motion of the *Shadow* irregular in all parts of the Earth, unleſs under the two *Poles*, and that more or leſs according to the Conſtitution of the *Sphere*, and the Situation of the *Plane*.

And therefore by Art there is found out Rules to mark out the irregular Motion of the *Shadow* in all *Latitudes*, and on all *Planes*, to comply with the regular Motion of the Sun. And theſe Rules of adjuſting the Motion of the *Shadow* to the motion of the *Sun*, may be called the Art of *Shadows*.

Of the ſeveral ſorts of Planes *upon which* DIALS *are uſually made.*

Definitions.

A *Dial Plane* is that Flat whereon a *Dial* is intended to be made.

Of *Dial Planes* ſome be *Direct*, others *Decliners*, and others *Oblique*.

Of *Direct Planes* there are five ſorts.

1. The *Horizontal* whoſe Plane lies flat, and is parallel to the *Horizon*, beholding the *Zenith*.

2. The *South Erect*, whoſe Plane ſtands upright, and directly beholds the *South*.

3. The *North Erect*, whoſe Plain ſtands upright, and directly beholds the *North*.

4. The *Eaſt Erect*, whoſe Plane ſtands upright and directly beholds the *Eaſt*.

5. The *Weſt Erect*, whoſe Plane ſtands upright, and directly beholds the *Weſt*.

Of *Decliners* there are infinite; and yet may be reduced into theſe two *Kinds*.

1. The *South Erect* Plane, declining more or leſs towards the *Eaſt* or *Weſt*.

2. The *North Erect* Plane, declining more or leſs towards the *Eaſt* or *Weſt*.

Of *Oblique Planes* ſome are *Direct*, others *Declining*. Now an *Oblique* Plane is (as to explain it to a mean Capacity) a Plain, or Dial which falls or leaneth from you like the Rufe of an Houſe, and are of theſe Kinds:

1. The Direct *South* Dial Reclining.
2. The Direct *North*-Dial Reclining.
3. The Direct *Eaſt* or *Weſt* Reclining.
4. The *North* and *South* Declining Reclining Dials.

Note 1. That all Angles are uſually meaſured by a Line of Chords, whoſe *Radius* or *Semidiameter* is equal to the Chord of 60 deg. and do contain 90 deg. which is a *Quadrant*; ſometimes by a *Tangent line*.

2. If the Hours of a *Dial* be never ſo truly drawn, if the Stile be not well plac'd, it will not go exact; therefore obſerve theſe three Rules in ſetting your Stile.

1. That it has the ſame Center (if there be any) with the Subſtile and Hours.
2. Its due Angle.
3. That it ſtands *perpendicular* to the Subſtile.

Multum

THE
Art of Shadows:
OR,
TABLELS, *&c.*

Chap. I. Fig. IV.

How to draw an Horizontal *Dial.*

1. DRAW the Line AB, for *6* and *6* Morning and Evening.

2. Draw NS, *perpendicular* to AB; this ſhall be the 12 a Clock *Hour-line.*

3. Let C, the Interſection of the foreſaid Lines be the *Center* of the *Dial*, then take in your Compaſſes 60 deg. of a Line of Chords, and with that Diſtance upon the Center C draw an obſcure Segment of a *Circle*, as A*m*B.

4. Turn to your Table of *Horizontal Spaces*, and ſee what Degrees and Minutes anſwer to 11 and 1 a Clock; you find they are 11 deg. 51 min. take therefore 11 deg. 51 min. out of your Line of Chords, and ſet it from *m* to *aa*, on both ſides the 12 a Clock Line.

Likewiſe take 24 Deg. 20 Min. for 10 and 2 a Clock, and ſet it from *m* to *bb*. Take 38 deg. 4 min. and ſet from *m* to *cc*; work after the ſame manner for the remaining Hours.

5. From the Center C, thro' each of theſe Points *a*, *b*, *c*, *d*, *e*, draw Lines, which ſhall be the Hours required. The intermedial Spaces, *viz.* Quarters, Half, and Three Quarters of an Hour, are drawn after the ſame Method.

Laſtly, The Stile of your *Dial* muſt always make an Angle equal to the *Latitude* of the Place. Take therefore 51 deg. 30 min. out of your Line of Chords and ſet it from *m* to *n*, thro' C and *n* draw the Line C *n*.

Note 1. That the Stile muſt ſtand at Right Angles with the *Plane* upon the 12 a Clock-Line.

2. That the 12 a Clock-Line muſt be ſet exactly *North* and *South*.

3. That the whole *Plane* muſt be laid *parallel* to the *Horizon*.

4. That the 2 Hours above the Line of 6, are drawn by extending the two oppoſite *Hour-Lines* thro' the *Center*, as 4 in the Morning is drawn by extending 4 in the Afternoon, *&c.*

CHAP. II. FIG. V.

How to draw the Hour-Lines *upon a* Direct South-Dial.

THERE is little Difference between deſcribing a *South Dial* and an *Horizontal Dial*; only Obſerve,

1. That the Angle which every *Hour-Line* makes with the *Meridian* muſt be taken from the Table of *South-Dial Spaces*, and prick'd down on

the *Segment* of the Circle A, B, *m*, as before directed in the *Horizontal Dial.*

2. That the Angle which the Stile makes with the *Meridian* muſt be 38 deg. 30 min. always the Complement of your *Latitude.*

Note; That the Stile muſt ſtand at Right Angles with the *Plane.*

2. That the Face of the *Dial* muſt look exactly *South*, and be placed *perpendicular* to the *Horizon.*

CHAP. III. *Fig.* 6.

How to draw the Hour-lines *upon* a Direct North Dial.

A *Direct North Dial*, is the ſame with a *Direct South Dial*; for, if you take a *South Dial* and turn it upſide down, cauſing the Stile to point upwards, as the Stile of the *South* doth downwards, and leaving out the Hours near the *Meridian*, in theſe *Northern Latitudes:* as the Hours of 9, 10, 11, and 12 at Night, and 1, 2, and 3 in the Morning, all which time the Sun is under the *Horizon.* I ſay a *South Dial* ſo inverted, and fixed againſt a direct *North Wall*, ſhall give the true hour of the Day.

CHAP. IV. *Fig.* 7.

How to draw the Hour-lines *upon a* Direct, East *or* Weſt Dial.

1. UPON the point C, if it be an *Eaſt Dial*, or upon the point D, if a *Weſt*, with 60 deg. of your line of Chords draw an obſcure *Segment*

of a Circle E F; then take 38 deg. 30 min. the Complement of your *Latitude*, and ſet it from E to F, and draw C E thro' the *Plane*. Call this Line the *Equinoctial*.

2. Aſſume any two points in this *Equinoctial* at a convenient diſtance for the *Hour-lines* of 11 and 6; and thro' theſe points G H, draw *perpendiculars* to the *Equinoctial*.

3. On G with 60 deg. of your Line of Chords, deſcribe an obſcure Arch of a Circle I K, and ſet thereon 15 deg. from I to K, and draw the Line G K, to cut the *Hour-line* of 6 in the Point L, ſo ſhall L H be the height of the *perpendicular* Stile proportioned to this *Plane*.

4. Upon L with 60 deg. of Chords, deſcribe an Arch of a Circle M, N: betweent the *Hour-line* 6 and G L. Divide the Arch M N, into five equal parts with 15 deg. of Chords. Then turn to your Table for *Eaſt* and *Weſt Dials*, and ſee what number ſtands againſt each hour, [and the Intermediate Spaces, if you pleaſe to put them in] take the ſaid numbers out of your Line of Chords; and put them upon the Arch M N, from M to N.

5. Lay a Rule from L to each of the Diviſions ⊙⊙⊙, *&c.* and where the Rule interſects the *Equinoctial* line, make marks ***, *&c.* Lines drawn thro' theſe points ***, *&c.* *Parallel* to the *Hour-line* of 6, ſhall be the true *Hour-lines* for an *Eaſt Dial* from 6 to 11; but if you transfer the ſame diſtances on the *Equinoctial* before 6, as there is after 6, and thro' theſe diſtances draw lines *parallel* to 6; you have alſo the hours before 6, as 5, 4, *&c.*

Note; 1. That the Stile may be a plate of Braſs or Iron of the ſame breadth as is the diſtance between 6 and 9 on the *Equinoctial*, and fixed upon the line of 6, *perpendicular* to the *Plane*.

2. That an *Eaſt* and *Weſt Dial* is the ſame in all Reſpects, ſave that the hour lines of 4, 5, 6, 7, 8, in the Morning in the *Eaſt Dial*, muſt be 8, 7, 6, 5, 4, in the Evening on the *Weſt Dial*.

CHAP. V. *Fig.* 8.

How to draw the Hour-lines *upon* South *or* North Planes, *Declining either* Eaſt *or* Weſt, 30 *deg.*

1. DRAW the Line NS for 12 a Clock *Hour-line*.

2. In this Line choſe a *Center* as C, upon which with 60 degrees of Chords, deſcribe an obſcure Circle.

3. Turn to your Table of *Requſites*, and ſee what is the Subſtiles diſtance for 30 degrees of *Declination*; 'Tis 21 deg. 40 min. take the ſaid diſtance out of your Line of Chords, and ſet it from M to S: thro' C and *S* draw an obſcure Line for the Subſtile.

4. Now turn to your *Declination*, in the Tables of *Hour diſtances* for the Subſtile, and ſee what numbers ſtands againſt each Hour [and ¼ part, if you would inſert them in your *Dial*] tranſfer theſe numbers by help of your Line of Chords into the *Circle* from S, towards A B; and thro' the Points draw Lines from C, the *Center* of your *Dial*; theſe are the hours required.

5. And *Laſtly*, In your Table of *Requiſites*, under the *Stiles* height, and oppoſite to 30 deg. of *Declination*, you'll find 32 deg. 37 min. Set

this diſtance from S to T, then draw C T, an you have the height of the Stile or Gnomon.

Note 1. That the larger the Radius of you Line of Chords is, the better you may inſert th Hour-lines.

2. If the Declination be *Eaſt*, the Subſtile mu be placed on the left ſide of the *Meridian:* an thoſe hours that are next to the numbers in you Table muſt be uſed: but the contrary, if th Declination be *Weſt*.

3. If the Face of your *Dial* be towards th *North*, you muſt turn the *Dial* the bottom upwards and reckon the Hours the contrary way; So *South Eaſt Decliner* will be a *North Eaſt* De*cliner*, and a *South Weſt Decliner*, will be a *Nort Weſt Decliner* leaving out the *Hour-lines*, [whic will be needleſs] before Sun-ſetting, and afte Sun-riſing.

4. That the Stile muſt be fix'd upon the Sub ſtile, and ſtand at Right Angles with the *Plane*.

CHAP. VI. *Fig.* 9

How to draw the Hour-lines *upon an* Equinoctia Plane.

1. DRAW the Right Line AB, for the Horizontal Line of the *Plane*, and croſs i about the middle thereof at Right Angles, wit a Line 12 Q 12, for the *Meridian* and *Hour-lin* of 12

2 Upon the Line 12 Q 12, either above o below Q, aſſume any Point at S, and ſetting on foot of your Compaſſes therein, [it being opene

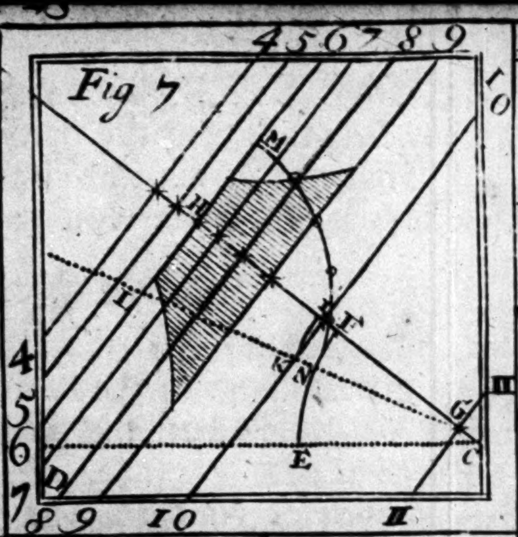
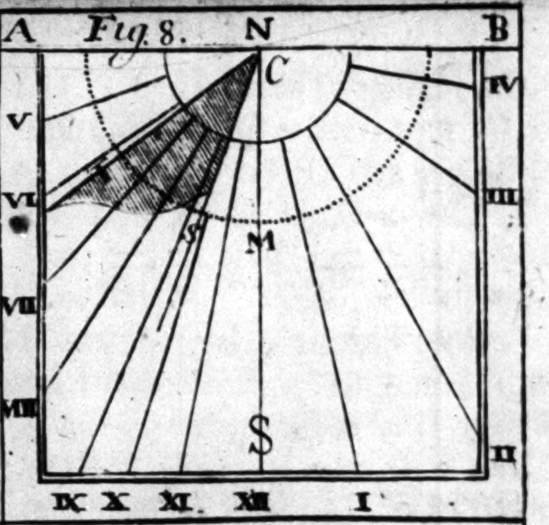


Fig 7


A Fig. 8. N B

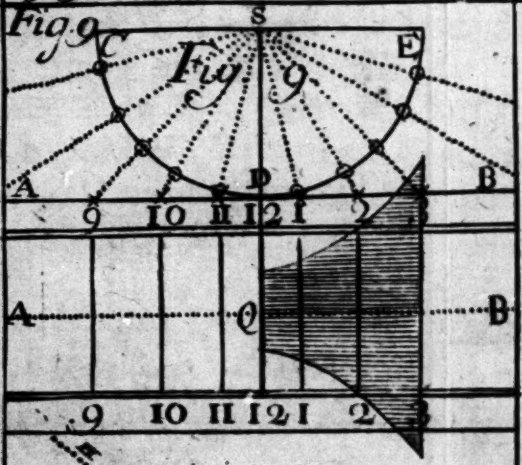


Fig. 9

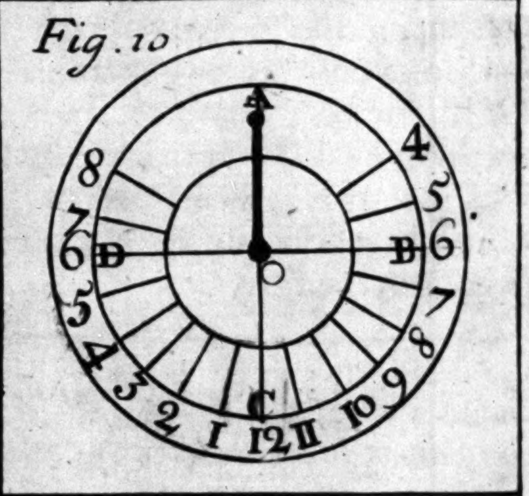


Fig. 10

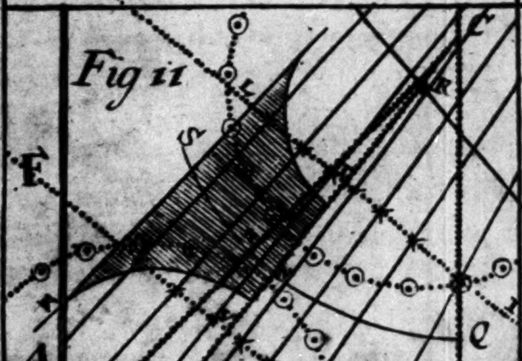


Fig 11

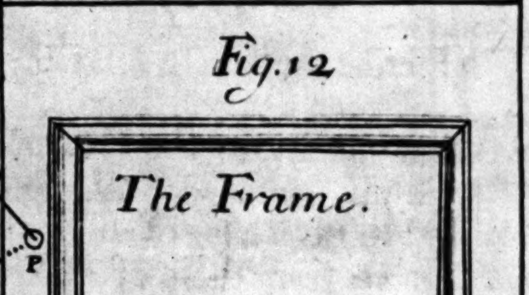


Fig. 12

to the *Radius* of your Line of Chords] deſcribe the Circle CDE, which divide into 12 equal parts, beginning at D.

3. Lay a Rule to S, and the ſeveral points ⊙⊙⊙, *&c.* and it will cut the Line AB, in the points ✳✳✳, *&c.*

Laſtly, Through theſe points ✳✳✳, *&c.* draw Right Lines all *parallel* to the Line 12 Q 12, and ſo your *Dial* is finiſhed.

The *Stile* may be either a ſtreight Pin, of the length of the Line QS, and ſet perpendicular to the Plane, upon the point Q; the ſhadow of the Top thereof only giving the Hour.

Or it may be a plate of Braſs or Iron, of the breadth of the diſtance that is between the *Hour-line* of 12 and 3, or 12 and 9. And then will the ſhadow of the upper edge thereof give the true hour of the Day.

CHAP. VII. *Fig.* 10.

How to draw the Hour-lines *upon a* Direct Polar Plane.

1. DEſcribe the Circle ABDE, with 60 deg. of your Line of Chords.

2. Draw the Diameters AC and AD at Right Angles, in the Center O, AC ſhall be the hour of 12, and BD the hour of 6.

3. Turn to your Table of *Polar Dial*, and ſee what numbers anſwer to every hour, take the ſaid numbers from your line of Chords, and prick them down in the Circle ABCD, on both ſides the 12 a Clock-line: Draw lines from theſe Points thro' the Center O, and your work is done.

Note 1.

Note 1. That this *Plane*, by reaſon of its *North Reclination*, is in Summer, capable of receiving all the Hours from *Sun-riſing* to *Sun-ſetting*, and therefore the *Hour-lines* of 4 and 5 in the Morning, and of 7 and 8 at Night, muſt be drawn through the Center, as you did in the *Horizontal Dial*.

2. That the Hour-Line of 12 muſt ſtand exactly *North* and *South*.

3. That the *Plane* muſt be elevated the ſame number of Degrees towards the *South*, as the *Equator* is in your *Latitude*.

4. The Stile muſt be a ſtreight Pin or Wire, (ſet perpendicular to the *Plane*, from the Center O) of any length.

5. The *South inclining Plane* oppoſite to this, is directly the ſame, only the Forenoon hours in this muſt be the Afternoon in that, and the hours of 4 and 5 in the Morning, and of 7 and 8 in the Evening, muſt be omitted.

CHAP. VIII. *Fig.* 11.

How to draw the Hour-lines *upon* Far-Declining Dials.

BEcauſe the Tables extend no farther than 60 deg. of Declination, [and if they had been Calculated to 90 deg. they would have been of little uſe, becauſe the Stile's height being ſo ſmall, the *Hour-lines* would have been of no Competent Diſtance] and becauſe many times there may be Occaſion to make a *Dial* for a greater Declination, I will ſhew a *Geometrical* way to draw ſuch, by the help of a Line of Chords only.

Let the Declination given be 80 *deg. Eaſtwards.*

1. Draw a line BC, perpendicular to the *Horizon* of the *Plane*.

2. Upon C, with a Chord of 60 deg. deſcribe the Arch QS, then out of the Table of *Requiſites* take the Subſtile's diſtance, and ſet it from Q to N; take alſo the Stile's height, and ſet it from N to *b*.

3. Draw CD for the Subſtile, and CE for the Stile: Then at any convenient diſtance draw KL, parallel to CE the Stile. Alſo aſſume any two points in the Subſtile, and thro' them draw the perpendiculars FG, and HI.

4. Take the neareſt diſtance from T to KL, and from V to KL, and ſet it from T to R, and from V to D.

5. Upon D and R, with 60 deg. of Chords, deſcribe two Arches of a Circle, and ſet off the Inclination of the *Meridian* from T to P, and from V to O. With 15 deg. of Chords divide the Segments into equal parts, beginning at O and P.

6. Lay a Rule on D, and on each diviſion in the Arch V O, and mark the Interſection of the Rule with the Line FG. Then lay the Rule to *R*, and work after the ſame manner in the other Arch, and HI.

7. Thro' the marks made in HI, and GF, draw the *Hour-lines*.

Note 1. When the *Plane* declines *Weſtward*, the perpendicular CB muſt be put on the Right-hand.

2. That the Inclination of the *Meridian* muſt be ſet on the ſame ſide of the Subſtile with the Perpendicular.

Thus have you finiſhed your *Dial*, and in the making of this you have made a *South* declining *Weſt* 80 deg. alſo; for if you turn the paper, and look through it, it will on the back-ſide be a *South* declining *Weſt* 80 deg. only the Forenoon hours in this, muſt be Afternoon in that: Nay, of right you have made in this one *Dial* Four, *viz.* a *North*, declining either *Eaſt* or *Weſt*, if you well obſerve what was ſaid of the *Dial* declining 30 deg.

C H AP. IX.

How to place an Upright Dial *truly.*

ALL *Upright Dials*, in what Latitude ſoever, have the *Meridian* perpendicular to the *Horizon*, Therefore to ſet your *Dial* exact, hang a Line with a Plummet at the end thereof, upon a nail fixt in the line of 12 toward the top; then apply your *Dial* to the place where it is to be fixt, ſo that the line and plummet may hang juſt down upon the line of 12: The *Dial* thus fixt (if the *Declination* be truly taken, and the *Dial* made by the former directions) will at all times (if the *Sun*'s on it) give the true hour of the Day.

Note. In every *Dial* truly placed, if you ſtand on the *South-ſide* of the *Plane* looking *Northward*, the *Hours* on your *left-hand* of the *Meridian*. are the *Morning-Hours*, on your *right-hand* are the *Evening-Hours*; but if you ſtand on the *North-ſide* of the *Plane*, your *Face* being *Southward*, then the *Forenoon Hours* are on your *right-hand*, and the *Afternoon-Hours* on your *left-hand*; becauſe your *right-hand*, in relation to the *Plane*, is where your *left-hand* was.

The

The Three Requiſites in Dialling, Calculated to every Degree of Declination, in the Latitude 51 deg. 30 min.

Declination.	*Sub-ſtile's Diſtance Meridian.*		*Stile's height.*		*Inclination of Meridian.*		*Declination.*	*Sub-ſtile's Diſtance Meridian.*		*Stile's height*		*Inclination of Meridian*	
°	d.	m.	d.	m.	d.	m.		d.	m.	d.	m.	d.	m.
1	00	48	38	29	01	17	22	16	36	35	16	27	18
2	01	36	38	28	01	33	23	17	16	34	57	28	39
3	02	23	38	26	03	49	24	17	56	34	39	29	38
4	03	11	38	23	05	07	25	18	37	34	21	30	47
5	03	58	38	20	06	23	26	19	13	34	01	31	56
6	04	45	38	15	07	39	27	19	50	33	42	33	04
7	05	32	38	10	08	55	28	20	29	33	20	34	12
8	06	19	38	04	10	11	29	21	05	32	59	35	19
9	67	05	37	57	11	27	30	21	40	32	37	36	25
10	07	52	37	49	12	42	31	22	15	32	15	37	31
11	08	38	37	40	13	57	32	22	50	31	52	38	36
12	09	23	37	30	15	10	33	23	25	31	27	39	41
13	10	08	37	21	16	26	34	23	59	31	04	40	46
14	10	54	37	10	17	40	35	24	31	30	40	41	49
15	11	38	36	58	18	54	36	25	04	30	14	42	52
16	12	22	36	43	20	07	37	25	35	29	48	43	55
17	13	05	36	32	21	20	38	26	04	29	22	44	58
18	13	49	36	18	22	33	39	26	35	28	56	45	59
19	14	31	36	03	23	45	40	27	03	28	29	47	00
20	15	13	35	48	24	57	41	27	33	28	01	48	00
21	15	54	35	31	26	08	42	23	01	27	33	49	00

The Three Requiſites in Dialling, Calculated to euery Degre of Declination, in the Latitude 51 deg. 30 min.

Declination.	Sub-ſtile's Diſtance Meridian.		Stile's height.		Inclination of Meridian.		Declination.	Sub-ſtile's Diſtance Meridian.		Stile's height		Inclination of Meridian	
	d.	m.	d.	m.	d.	m.		d.	m.	d.	m.	d.	m
43	28	29	27	05	50	00	67	36	13	14	05	71	38
44	28	55	26	36	50	59	68	36	25	13	29	72	27
45	29	21	26	07	51	57	69	35	36	12	53	73	16
46	29	46	25	37	52	55	70	36	46	12	18	74	06
47	30	11	25	07	53	53	71	36	55	11	41	74	55
48	30	35	24	38	54	50	72	37	06	11	06	75	44
49	30	58	24	06	55	46	73	37	15	10	29	76	33
50	31	21	23	35	56	42	74	37	24	09	53	77	21
51	31	45	23	04	57	38	75	37	32	09	16	78	09
52	32	05	22	32	58	33	76	37	40	08	40	78	57
53	32	26	22	00	59	28	77	37	47	08	03	79	46
54	32	46	21	28	60	23	78	37	57	07	27	80	33
55	33	06	20	55	61	17	79	37	59	06	49	81	21
56	33	24	20	22	62	10	80	38	04	06	12	82	09
57	33	42	19	49	63	04	81	38	09	05	35	82	56
58	34	00	19	16	63	57	82	38	14	04	58	83	43
59	34	15	18	42	64	49	83	38	17	04	20	84	31
60	34	33	18	06	65	41	84	38	21	03	44	85	18
61	34	47	17	34	66	33	85	38	23	03	06	86	05
62	35	05	17	00	67	24	86	38	26	02	28	86	52
63	35	18	16	25	68	16	87	38	28	01	52	87	39
64	35	34	15	50	69	07	88	38	29	01	15	88	26
65	35	43	15	15	69	57	89	38	29	00	37	89	13
66	36	00	14	40	70	47	90	38	30	00	00	90	00

A Table of Horizontal Spaces, ſhewing the *Diſtance* of each *HOUR-LINE* from the *MERIDIAN*: upon *DIRECT NORTH* or *SOUTH* Planes, whether *Erect*, *Reclining* or *Inclining*: Calculated to every Degree of *LATITUDE*.

An Horizontal Dial, Latitude.	xi.	i.	x.	ii	ix.	iii.	viii.	iv.	vii.	v.	vi.		*A Direct South Dial, Latitude.*
	d,	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
0	0	0	0	0	0	0	0	0	0	0	0	00	90
1	0	16	0	34	1	0	1	44	3	44	90	00	89
2	0	32	1	9	2	0	3	27	7	25	90	00	83
3	0	48	1	44	3	0	5	11	11	3	90	00	87
4	1	5	2	19	4	0	6	54	14	36	90	00	86
5	1	20	2	52	4	58	8	35	18	1	90	00	85
6	1	36	3	27	5	58	10	16	21	19	90	00	84
7	1	52	4	3	6	57	11	55	24	27	90	00	83
8	2	8	4	37	7	55	13	33	27	23	90	00	82
9	2	23	5	9	8	54	1[illegible]	10	30	17	90	00	81
10	2	40	5	43	9	51	16	44	32	57	90	00	80
11	2	55	6	17	10	48	18	17	35	27	90	00	79
12	3	11	6	51	11	45	19	48	37	49	90	00	78
13	3	27	7	24	12	41	21	17	40	1	90	00	77
14	3	43	7	57	13	36	22	44	42	4	90	00	76
15	3	58	8	30	14	31	24	9	44	0	90	00	75
16	4	13	9	2	15	25	25	31	45	49	90	00	74
17	4	29	9	35	16	26	26	52	47	26	90	00	73
18	4	44	10	8	17	10	28	9	49	4	90	00	72
19	4	59	10	39	18	2	29	25	50	33	90	00	71
20	5	14	11	10	18	53	30	39	51	55	90	00	70
21	5	29	11	41	19	44	31	50	53	9	90	00	69
22	5	44	12	13	20	32	32	58	54	21	90	00	68
23	5	59	12	43	21	20	34	5	55	30	90	00	67
24	6	13	13	13	22	8	35	10	56	37	90	00	66
25	6	28	13	43	22	55	36	12	57	34	90	00	65
26	6	42	14	12	23	40	37	13	58	34	90	00	64

A TABLE of *Horizontal Spaces*, &c.

An Horizontal Dial, Latitude.	xi.	i.	x.	ii.	ix.	iii.	viii.	iv.	vii.	v.		vi.	*A Direct South Dial, Latitude.*
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
27	6	56	14	41	24	25	38	11	59	27	90	00	63
28	7	10	15	10	25	9	39	7	60	17	90	00	62
29	7	24	15	40	25	52	40	2	61	4	90	00	61
30	7	38	16	6	26	33	40	54	61	49	90	00	60
31	7	50	16	34	27	15	41	44	62	30	90	00	59
32	8	5	17	1	27	55	42	30	63	11	90	00	58
33	8	19	17	27	28	34	43	20	63	49	90	00	57
34	8	31	17	54	29	13	44	5	64	24	90	00	56
35	8	44	18	20	29	50	44	49	64	58	90	00	55
36	8	57	18	45	30	27	45	31	65	30	90	00	54
37	9	10	19	9	31	2	46	12	66	10	90	00	53
38	9	22	19	34	31	37	46	50	66	29	90	00	52
39	9	34	19	58	32	11	47	28	66	56	90	00	51
40	9	45	20	21	32	44	48	7	67	21	90	00	50
41	9	57	20	44	33	16	48	39	67	47	90	00	49
42	10	10	21	7	33	46	49	12	68	11	90	00	48
43	10	22	21	29	34	18	49	44	68	33	90	00	47
44	10	32	21	51	34	47	50	10	68	54	90	00	46
45	10	43	22	12	35	17	50	46	69	15	90	00	45
46	10	54	22	33	35	44	51	15	69	35	90	00	44
47	11	05	22	53	36	11	51	42	69	53	90	00	43
48	11	17	23	13	36	37	52	9	70	11	90	00	42
49	11	25	23	33	37	3	52	35	70	28	90	00	41
50	11	35	23	52	37	28	53	00	70	43	90	00	40
51	11	45	24	9	37	52	53	24	70	59	90	00	39
52	11	55	24	27	38	15	53	46	71	13	90	00	38
53	12	5	24	43	38	37	54	18	71	28	90	00	37
54	12	13	25	2	38	58	54	29	71	41	90	00	36
55	12	22	25	18	39	19	54	49	71	54	90	00	35
56	12	32	25	34	39	40	55	9	72	5	90	00	34
57	12	40	25	50	39	59	55	28	72	17	90	00	33
58	12	48	26	5	40	81	55	45	72	28	90	00	32

A TABLE of *Horizontal Spaces*, &c.

An Horizontal Dial, Latitude.	xi. i.		x. ii		ix. iii.		viii. iv.		vii. v.		vi.		*A Direct South Dial, Latitude.*
	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	d.	m.	
59	12	56	26	20	40	36	56	3	72	38	0	90	31
60	13	4	26	34	40	54	56	19	72	48	90	00	30
61	13	11	26	47	41	10	56	34	72	58	90	00	29
62	13	19	27	1	41	21	56	49	73	7	90	00	28
63	13	26	27	13	41	42	57	3	73	15	90	00	27
64	13	32	27	25	41	57	57	17	73	24	90	00	26
65	13	39	27	37	42	15	57	30	73	32	90	00	25
66	13	46	27	49	42	25	57	43	73	39	90	00	24
67	13	51	27	59	42	38	57	54	73	46	90	00	23
68	13	57	28	9	42	50	58	5	73	53	90	00	22
69	14	3	28	19	43	2	58	16	73	59	90	00	21
70	14	8	28	29	33	13	58	26	74	05	90	00	20
71	14	13	28	37	43	18	58	35	74	11	90	00	19
72	14	18	28	46	43	24	58	44	74	16	90	00	18
73	14	22	28	54	43	36	58	52	74	20	90	00	17
74	14	27	29	2	43	52	59	00	74	25	90	00	16
75	14	30	29	7	44	00	59	7	74	30	90	00	15
76	14	33	29	15	44	8	59	15	74	34	90	00	14
77	14	37	29	21	44	14	59	22	74	37	90	00	13
78	14	41	29	27	44	22	59	27	74	41	90	00	12
79	14	44	29	32	44	28	59	32	74	44	90	00	11
80	14	47	29	37	44	34	59	37	74	47	90	00	10
81	14	49	29	41	44	37	59	40	74	49	90	00	9
82	14	51	29	45	44	40	59	44	74	51	90	00	8
83	14	53	29	49	44	44	59	47	73	53	90	00	7
84	14	55	29	52	44	48	59	51	74	55	90	00	6
85	14	56	29	54	44	53	59	54	74	57	90	00	5
86	14	57	29	55	44	55	59	55	74	58	90	00	4
87	14	58	29	56	44	56	59	56	74	58	90	00	3
88	14	59	29	57	44	57	59	58	74	59	90	00	2
89	14	59	29	58	44	58	59	59	74	59	90	00	1
90	15	00	30	00	45	00	60	00	75	00	90	00	

A Table of *Horizontal Spaces*, Exactly Calculated for the *Latitude* of *LONDON*: Shewing what Angle, every Five Minutes makes with the *Meridian*, upon an *Horizontal Dial*.

Hours.		d.	m.	*Hours.*		d.	m.	*Hours.*		d.	m.
xii.		00	00	ii.	x.	24	20	iv.	viii.	53	36
5	55	00	59	5	55	25	25	5	55	54	59
10	50	1	58	10	50	26	30	10	50	56	23
15	45	2	57	15	45	27	37	15	45	57	48
20	40	3	55	20	40	28	44	20	40	59	14
25	35	4	54	25	35	29	51	25	35	60	40
30	30	5	53	30	30	30	59	30	30	62	10
35	25	6	53	35	25	32	00	35	25	63	35
40	20	7	32	40	20	33	18	40	20	65	4
45	15	8	51	45	15	34	29	45	15	66	34
50	10	9	51	50	10	35	40	50	10	68	4
55	5	10	51	55	5	36	51	55	5	69	35
i.	xi.	11	51	iii.	ix.	38	4	v.	vii.	71	6
5	55	12	51	5	55	39	17	5	55	72	39
10	50	13	52	10	50	40	31	10	50	74	12
15	45	14	53	15	45	41	45	15	45	75	45
20	40	15	54	20	40	43	1	20	40	77	20
25	35	16	56	25	35	44	18	25	35	78	35
30	30	17	58	30	30	45	35	30	30	80	27
35	25	19	00	35	25	46	55	35	25	82	2
40	20	20	04	40	20	48	12	40	20	83	36
45	15	21	07	45	15	49	31	45	15	85	13
50	10	23	11	50	10	50	52	50	10	86	49
55	0	23	12	55	5	52	13	55	5	88	24
								vi.	vi.	90	00

A Table ſhewing what Angle every Hour Quarters, Halfs, and Three Quarters of an Hour, makes in a Direct South Dial.

Hours.		d.	m.
xii.		00	00
1	3	2	21
2	2	4	41
3	1	7	4
i.	xi.	9	28
1	3	11	57
2	2	14	28
3	1	17	4
ii.	x.	19	46
1	3	22	35
2	2	25	32
3	1	28	38
iii.	ix.	31	54
1	3	35	22
2	2	39	3
3	1	42	58
iv.	viii.	47	9
1	3	51	37
2	2	56	21
3	1	61	24
v.	vii.	66	43
1	3	72	17
2	2	78	3
3	1	83	59
vi.		90	

A Table for East *and* Weſt Dials.

Hours.		d.	m.
vi.		00	00
1	3	3	45
2	2	7	30
3	1	11	15
vii.	v.	15	00
1	3	18	45
2	2	22	30
3	1	26	15
viii.	iv.	30	00
1	3	33	45
2	2	37	30
3	1	41	15
ix.	iii.	45	00
1	3	48	45
2	2	52	30
3	1	56	15
x.	ii.	60	00
1	3	63	45
2	2	67	30
3	1	72	15
xi.	i.	75	00

A Table ſhewing what Angle every Hour, Quarters, Halfs, and Three Quarters of an Hour makes in a Polar Dial.

Hours.		d.	m.
xii.		00	00
1	3	3	45
2	2	7	30
3	1	11	15
i.	xi.	15	00
1	3	18	45
2	2	22	30
3	1	26	15
ii.	x.	30	00
1	3	33	45
2	2	37	30
3	1	41	15
iii.	ix.	45	00
1	3	58	45
2	2	52	30
3	1	56	15
iv.	viii.	60	00
1	3	63	45
2	2	67	30
3	1	72	15
v.	vii.	75	00
1	3	78	45
2	2	82	30
3	1	86	15
vi.		90	00

A TABLE of *Hour Diſtances*, and Parts of an *Hour* from the *Subſtile*, in *Declining Dials*, in the Latitude 51 deg. 30 min.

South Delining 1. 00.				*South Declining* 2 00.				*South Declining* 3. 00			
Hours.		d.	m.	*Hours.*		d.	m.	*Hours.*		d.	m.
vi.		93	28	vi.		94	06	vi.		96	06
1	3	86	[illegible]	1	3	86	28	1	3	90	06
2	2	80	4	2	2	80	24	2	2	84	05
3	1	74	14	3	1	76	11	3	1	78	09
vii.	v.	68	35	vii.	v.	70	27	vii.	v.	72	21
1	3	63	11	1	3	64	58	1	3	66	47
2	2	58	2	2	2	59	44	2	2	61	28
3	1	53	11	3	1	54	47	3	1	56	24
viii.	iv.	48	38	viii.	iv.	50	08	viii.	iv.	52	18
1	3	44	22	1	3	45	46	1	3	47	11
2	2	39	41	2	2	41	40	2	2	43	00
3	1	36	47	3	1	37	50	3	1	39	04
ix.	iii.	33	3	ix.	iii.	34	13	ix.	iii.	35	25
1	3	28	52	1	3	30	49	1	3	31	56
2	2	25	44	2	2	27	36	2	2	28	39
3	1	22	48	3	1	24	33	3	1	25	33
x.	ii.	20	43	x.	ii.	21	39	x.	ii.	22	36
1	3	17	59	1	3	18	42	1	3	19	48
2	2	15	20	2	2	16	13	2	2	17	05
3	1	12	47	3	1	13	38	3	1	14	29
xi.	i.	10	18	xi.	i.	10	38	xi.	i.	11	57
1	3	7	52	1	3	08	42	1	3	09	30
2	2	5	29	2	2	06	18	2	2	07	05
3	1	3	9	3	1	03	55	3	1	04	43
xii.		0	48	xii.		01	36	xii.		02	23
Sub-		ſtile		Sub-		ſtile		1	3	00	03
1	3	1	52	1	3	00	55	Sub-		ſtile	
2	2	3	53	2	2	03	05	2	2	02	18
3	1	6	14	3	1	05	26	3	1	04	38

(1)				(2)				(3)			
i	xi	08	38	i	xi	07	49	i	xi	07	00
1	3	11	04	1	3	10	15	1	3	09	25
2	2	13	30	2	2	12	43	2	2	11	52
3	1	16	10	3	1	15	16	3	1	14	24
ii	x	18	50	ii	x	17	45	ii	x	17	00
1	3	21	36	1	3	20	39	1	3	19	41
2	2	24	30	2	2	23	30	2	2	22	30
3	1	82	05	3	1	27	01	3	1	25	27
iii	ix	30	45	iii	ix	29	39	iii	ix	28	32
1	3	34	09	1	3	33	00	1	3	31	48
2	2	37	45	2	2	36	32	2	2	35	16
3	1	41	46	3	1	40	15	3	1	38	56
iv	viii	45	41	iv	viii	44	17	iv	viii	42	52
1	3	50	07	1	3	48	33	1	3	47	02
2	2	54	04	2	2	53	05	2	2	51	30
3	1	59	58	3	1	57	55	3	1	56	14
v	vii	64	51	v	vii	63	03	v	vii	61	16
1	3	70	21	1	3	68	27	1	3	66	38
2	2	76	04	2	2	74	06	2	2	72	09
3	1	81	55	3	1	79	57	3	1	77	56
	vi	87	56		vi	85	54		vi	83	53

South Declining. 04 00				*South Declining.* 05 00				*South Declining.* 06 00			
Hours		D.	M.	Hours		D.	M.	Hours		D.	M.
	vi	99	12	2	2	88	13	2	2	90	15
1	3	92	12	3	1	82	11	3	1	84	12
3	2	86	11	vii	v	76	17	vii	v	78	14
2	1	80	11	1	3	70	32	1	3	72	25
vii	v	74	19	2	2	65	01	2	2	66	49
1	3	68	40	3	1	59	47	3	1	61	28
2	2	63	15	viii	iv	54	49	viii	iv	56	25
3	1	58	06	1	3	50	10	1	3	51	39
viii	iv	53	14	2	2	45	44	2	2	47	10
1	3	48	40	3	1	41	40	3	1	42	49
2	2	44	24	ix	iii	37	50	ix	iii	39	03
3	1	40	23	1	3	34	13	1	3	35	22

(4)			
ix	iii	36	37
1	3	33	40
2	2	29	44
3	1	26	35
x	ii	23	35
1	3	20	45
2	2	18	00
3	1	15	21
xi	i	12	49
1	3	10	20
2	2	07	55
3	1	05	52
xii		03	11
1	3	00	51
Sub-		ſtile	
2	2	01	29
3	1	03	49
i	xi	06	11
1	3	08	34
2	2	10	43
3	1	13	30
ii	x	16	04
1	3	18	44
3	2	20	45
2	1	23	36
iii	ix	27	26
1	3	30	38
2	2	34	01
3	1	37	37
iv.	viii.	41	26
1	3	45	31
2	2	48	42
3	1	53	16
v.	vii.	59	28
1	3	64	41
2	2	70	11
3	1	75	53
vi.		81	48

(5)			
2	2	30	49
3	1	27	36
x	ii	24	33
1	3	21	39
2	2	18	53
3	1	16	13
xi	i	13	36
1	3	11	09
2	2	08	49
3	1	06	23
xii		03	50
1	3	01	38
Sub-		ſtile	
2	2	00	53
3	1	03	01
i	xi	05	23
1	3	07	45
2	2	10	10
3	1	12	38
ii	x	15	10
1	3	17	48
2	2	20	32
3	1	23	22
iii	ix	26	21
1	3	29	30
2	2	32	49
3	1	36	20
iv	viii	39	05
1	3	44	05
2	2	48	21
3	1	52	54
v	vii	57	44
1	3	62	52
2	2	68	16
3	1	73	57
vi		79	46
1	3	85	45

(6)			
2	2	31	54
3	1	28	38
x	ii	25	22
1	3	22	35
2	2	19	47
3	1	17	05
xi	i	14	30
1	3	11	58
2	2	09	31
3	1	07	07
xii		04	45
1	3	02	25
2	2	00	06
Sub-		ſtile	
3	1	02	14
i	xi	04	34
1	3	06	56
2	2	09	20
3	1	11	46
ii	x	14	17
1	3	16	52
2	2	19	34
3	1	22	22
iii	ix	25	17
1	3	28	22
2	2	31	37
3	1	35	04
iv	viii	38	52
1	3	42	39
2	2	46	49
3	1	51	16
v	vii	56	01
1	3	61	03
2	2	66	23
3	1	71	58
vi		77	46
1	3	83	43

South Declining.				*South Declining.*				*South Declining.*			
07	00			08	00			09	00		
Hours		D.	M.	Hours		D.	M.	Hours		D.	M.
2	2	92	18	2	2	94	26	2	2	96	16
3	1	86	14	3	1	88	17	3	1	90	23
vii	v	80	13	vii	v	82	13	vii	v	84	15
1	3	74	21	1	3	77	52	1	3	78	14
2	2	68	38	2	2	70	32	2	2	72	23
3	1	63	12	3	1	64	58	3	1	66	45
viii	iv	58	02	viii	iiii	59	42	viii	iiii	61	23
1	3	53	10	1	3	54	45	1	3	56	18
2	2	48	35	2	2	50	04	2	2	51	31
3	1	44	18	3	1	45	40	3	1	47	02
ix	iii	39	17	ix	iii	41	34	ix	iii	42	50
1	3	36	30	1	3	38	44	1	3	38	52
2	2	32	59	2	2	34	07	2	2	35	14
3	1	29	39	3	1	30	43	3	1	31	46
x	ii	26	30	x	ii	27	30	x	ii	28	24
1	3	23	32	1	3	24	49	1	3	25	25
2	2	20	40	2	2	21	36	2	2	22	29
3	1	17	57	3	1	18	49	3	1	19	41
xi	i	15	19	xi	i	16	10	xi	i	17	10
1	3	12	47	1	3	13	56	1	3	14	26
2	2	10	20	2	2	11	07	2	2	11	06
3	1	07	54	3	1	08	42	3	1	09	21
xii		05	32	xii		06	19	xii		07	05
1	3	02	42	1	3	03	59	1	3	04	45
2	2	00	53	2	2	01	40	2	2	02	26
Sub-		ſtile		Sub		ſtile		3	1	00	07
3	1	01	29	3	1	00	59	Sub		ſtile	
i	xi	03	36	i	xi	02	59	i	xi	02	11
1	3	06	06	1	3	05	19	1	3	04	30
2	2	08	30	2	2	07	40	2	2	06	51
3	1	10	55	3	1	10	04	3	1	09	13
ii	x	13	24	ii	x	12	33	ii	x	11	40
1	3	15	28	1	3	15	09	1	3	14	09
2	2	18	36	2	2	17	40	2	2	16	44
3	1	21	22	3	1	20	22	3	1	19	24

(7)				(8)				(9)			
iii	ix	24	19	iii	ix	23	13	iii	ix	22	08
1	3	27	16	1	3	26	11	1	3	25	09
2	2	30	28	2	2	29	19	2	2	28	10
3	1	33	50	3	1	32	37	3	1	31	25
iv	viii	37	26	iv	viii	36	08	iv	viii	34	15
1	3	41	16	1	3	39	52	1	3	38	30
2	2	45	20	2	2	43	52	2	2	42	22
3	1	49	21	3	1	48	08	3	1	46	34
v	vii	54	20	v	vii	52	40	v	vii	51	04
1	3	59	16	1	3	57	31	1	3	56	47
2	2	64	30	2	2	62	39	2	2	60	50
3	1	70	02	3	1	68	05	3	1	66	10
vi		75	45	vi		73	46	vi		71	46
1	3	81	40	1	3	79	38	1	3	77	36

South Declining 10 00.				*South Declining.* 11 00				*South Declining.* 12 00			
Hours		D.	M	Hours		D.	M.	Hours		D.	M.
3	1	92	22	3	1	94	25	3	1	96	25
vii	v	86	15	vii	v	88	17	vii	v	90	20
1	3	80	12	1	3	82	10	1	3	84	01
2	2	74	16	2	2	76	11	2	2	78	03
3	1	68	32	3	1	70	22	3	1	72	10
viii	iiii	63	04	viii	iv	64	48	viii	iv	66	29
1	3	57	53	1	3	59	30	1	3	61	05
2	2	53	00	2	2	54	30	2	2	55	19
3	1	48	25	3	1	49	49	3	1	51	12
ix	iii	44	07	ix	iii	45	25	ix	iii	46	42
1	3	40	06	1	3	41	19	1	3	42	30
2	2	36	21	2	2	37	59	2	2	38	36
3	1	32	49	3	1	33	53	3	1	34	56
x	ii	29	28	x	ii	30	30	x	ii	31	28
1	3	26	22	1	3	27	18	1	3	28	14
2	2	23	24	[illegible]	2	24	18	2	2	25	11
3	1	20	34	3	1	21	25	3	1	22	06

(10)				(11)				(12)			
xi	i	17	15	xi	i	18	40	xi	i	19	29
1	3	15	14	1	3	16	03	1	3	16	08
2	2	12	43	2	2	13	30	2	2	14	16
3	1	10	16	3	1	11	03	3	1	11	47
xii		07	52	xii		08	38	xii		09	23
1	3	05	31	1	3	06	17	1	3	07	00
2	2	03	12	2	2	03	51	2	2	04	40
3	1	00	54	3	1	01	39	3	1	02	23
Sub-		ſtile		Sub-		ſtile		i	xi	00	16
i	xi	01	25	i	xi	00	38	Sub-		ſtile	
1	3	03	43	1	3	02	57	1	3	02	11
2	2	06	02	2	2	05	15	2	2	04	29
3	1	08	24	3	1	07	35	3	1	06	48
ii	x	10	48	ii	x	09	59	ii	x	09	09
1	3	13	13	1	3	12	42	1	3	11	34
2	2	15	49	2	2	14	55	2	2	14	03
3	1	18	27	3	1	17	30	3	1	16	36
iii	ix	21	12	iii	ix	20	17	iii	ix	19	04
1	3	24	03	1	3	23	01	1	3	22	00
2	2	27	03	2	2	25	58	2	2	24	54
3	1	30	14	3	1	29	05	3	1	27	57
iv	viii	33	36	iv	viii	32	23	iv	viii	[illegible]	11
1	3	37	10	1	3	35	52	1	3	34	40
2	2	41	00	2	2	39	36	2	2	38	15
3	1	45	04	3	1	43	35	3	1	42	09
v	vii	49	26	v	vii	47	51	v	vii	46	20
1	3	54	04	1	3	52	37	1	3	50	49
2	2	59	02	2	2	57	16	2	2	55	33
3	1	64	17	3	1	62	16	3	1	60	37
vi		69	49	vi		67	52	vi		66	00
1	3	75	36	1	3	73	35	1	3	71	39
2	2	81	33	2	2	79	16	2	2	77	32

South Declining 13 00.				*South Declining.* 14 00				*South Declining.* 15 00			
Hours		D.	M.	Hours		D.	M.	Hours		D.	M
3	1	96	43	vii	v	94	25	vii	v	96	28
vii	v	90	43	1	3	88	13	1	3	91	16
1	3	86	11	2	2	82	01	2	2	84	02
2	2	80	04	3	1	75	58	3	1	77	54
3	1	74	05	viii	iv	70	06	viii	iv	71	56
viii	iiii	68	08	1	3	64	29	1	3	66	12
1	3	62	48	2	2	59	10	2	2	60	46
2	2	57	35	3	1	54	09	3	1	55	38
3	1	52	42	ix	iii	49	27	ix	iii	50	50
ix	iii	48	04	1	3	45	02	1	3	46	21
1	3	43	48	2	2	40	58	2	2	42	09
2	2	39	48	3	1	37	08	3	1	38	14
3	1	36	02	x	ii	33	33	x	ii	34	35
x	ii	32	32	1	3	30	11	1	3	31	09
1	3	29	13	2	2	27	01	2	2	27	56
2	2	26	06	3	1	24	02	3	1	24	53
3	1	23	09	xi	i	21	11	xi	i	22	00
xi	i	20	21	1	3	18	51	1	3	19	15
1	3	17	38	2	2	15	21	2	2	16	37
2	2	15	04	3	1	13	20	3	1	14	16
3	1	12	37	xii		10	54	xii		11	38
xii		10	08	1	3	08	31	1	3	09	15
1	3	07	47	2	2	06	11	2	2	06	55
2	2	05	27	3	1	03	54	3	1	04	37
3	1	03	09	i	xi	01	36	i	xi	02	21
i	xi	00	53	Sub-		ſtile		1	3	00	05
Sub-		ſtile		1	3	00	39	Sub-		ſtile	
1	3	01	24	2	2	02	55	2	2	02	10
2	2	03	41	3	1	05	12	3	1	04	26
3	1	06	00	ii	x	07	31	ii	x	06	43
ii	x	08	20	1	3	09	53	1	3	09	04
1	3	10	42	2	2	12	18	2	2	11	27
2	2	13	45	3	1	14	47	3	1	13	45
3	1	15	40	iii	ix	17	20	iii	ix	16	25

(13)

iii	ix	18	16
1	3	21	00
2	2	23	50
3	1	26	49
iv	viii	30	00
1	3	33	20
2	2	36	54
3	1	40	43
v	vii	44	43
1	3	49	09
2	2	53	49
3	1	58	47
	vi	64	04
1	3	69	39
2	2	77	04

(14)

1	3	19	18
2	2	22	01
3	1	24	56
iv	viii	28	50
1	3	32	06
2	2	35	35
3	1	39	19
v	vii	43	18
1	3	47	34
2	2	52	07
3	1	57	00
	vi	62	11
1	3	67	42
2	2	73	28
3	1	77	50

(15)

1	3	19	02
2	2	21	47
3	1	24	36
iv	viii	27	41
1	3	30	53
2	2	34	18
3	1	37	56
v	vii	41	41
1	3	45	58
2	2	50	28
3	1	55	14
	vi	60	21
1	3	65	46
2	2	71	28
3	1	77	24

South Declining.
16 00

Hours.		D,	M.
vii	v	98	31
1	3	92	17
2	2	86	01
3	1	79	49
viii	iv	73	45
1	3	67	55
2	2	62	21
3	1	57	07
ix	iii	52	11
1	3	47	36
2	2	43	18
3	1	39	19
x	ii	35	35
1	3	32	05
2	2	28	29
3	1	25	43

South Declining.
17 00

Hours		D.	M.
vii	v	100	33
1	3	94	20
2	2	88	02
3	1	81	37
viii	iv	75	38
1	3	69	42
2	2	64	02
3	1	58	40
ix	iii	53	58
1	3	48	56
2	2	44	33
3	1	40	24
x	ii	36	39
1	3	32	29
2	2	29	45
3	1	26	37

South Declining
18 00

Hours		D.	M.
vii	v	102	38
1	3	96	32
2	2	90	05
3	1	83	46
viii	iiii	77	32
1	3	71	30
2	2	65	43
3	1	60	14
ix	iii	55	04
1	3	50	16
2	2	45	46
3	1	41	36
x	ii	37	42
1	3	34	04
2	2	30	44
3	1	27	29

(16)

xi	i	22	48
1	3	20	01
2	2	17	22
3	1	14	49
xii		12	22
1	3	09	57
2	2	07	37
3	1	05	14
i	xi	03	04
1	3	00	49
Sub-		ſtile	
2	2	01	26
3	1	03	40
ii	x	05	57
1	3	08	15
2	2	10	36
3	1	13	00
iii	ix	15	30
1	3	18	05
2	2	20	47
3	1	23	34
iv.	viii.	26	33
1	3	29	41
2	2	33	01
3	1	36	34
v.	vii.	40	22
1	3	44	26
2	2	48	48
3	1	53	30
vi.		58	30
1	3	63	50
3	2	69	28
2	1,	75	23

(17)

xi	i	23	36
1	3	20	50
2	2	17	45
3	1	15	35
xii		13	05
1	3	10	41
2	2	08	21
3	1	06	05
i	xi	03	37
1	3	01	32
Sub-		ſtile	
2	2	00	53
3	1	02	56
ii	x	05	11
1	3	07	28
2	2	09	47
3	1	12	10
iii	ix	14	37
1	3	17	09
2	2	19	49
3	1	22	54
iv	viii	25	28
1	3	28	33
2	2	31	48
3	1	35	54
v	vii	38	59
1	3	42	58
2	2	47	53
3	1	51	49
vi		56	44
1	3	61	58
2	2	67	32
3	1	73	20

(18)

xi	i	24	28
1	3	21	38
2	2	18	54
3	1	16	18
xii		13	49
1	3	11	24
2	2	09	02
3	1	06	44
i	xi	04	29
1	3	02	16
2	2	00	02
Sub-		ſtile	
3	1	02	12
ii	x	04	25
1	3	06	12
2	2	08	59
3	1	11	20
iii	ix	13	45
1	3	16	14
2	2	18	50
3	1	21	33
iv	viii	24	24
1	3	27	24
2	2	30	35
3	1	33	58
v	vii	37	36
1	3	41	29
2	2	45	40
3	1	50	01
vi		54	58
1	3	60	06
2	2	65	34
3	1	71	21

South Declining.				South Declining.				South Declining.			
19		00		20		00		21		00	
Hours		D.	M.	Hours		D.	M.	Hours		D.	M.
1	3	98	28	1	3	100	31	1	3	102	39
2	2	92	07	2	2	96	16	2	2	96	14
3	1	85	44	3	1	83	47	3	1	89	48
viii	iv	79	28	viii	iiii	81	25	viii	iiii	83	22
1	3	73	19	1	3	75	11	1	3	77	02
2	2	67	26	2	2	69	10	2	2	70	55
3	1	61	50	3	1	63	27	3	1	65	04
ix	iii	56	32	ix	iii	57	21	ix	iii	59	32
1	3	51	37	1	3	53	00	1	3	54	32
2	2	47	00	2	2	48	16	2	2	49	31
3	1	42	44	3	1	43	45	3	1	45	02
x	ii	38	45	x	ii	39	50	x	ii	40	53
1	3	35	02	1	3	36	02	1	3	37	01
2	2	31	35	2	2	32	32	2	2	33	25
3	1	28	20	3	1	29	12	3	1	30	03
xi	i	25	17	xi	i	26	06	xi	i	26	51
1	3	22	23	1	3	23	10	1	3	23	56
2	2	19	39	2	2	20	24	2	2	21	08
3	1	17	02	3	1	17	45	3	1	18	28
xii		14	31	xii		15	13	xii		15	54
1	3	12	06	1	3	12	47	1	3	13	26
2	2	09	44	2	2	13	25	2	2	11	04
3	1	07	26	3	1	08	07	3	1	08	23
i	xi	05	11	i	xi	05	52	i	xi	06	32
1	3	02	59	1	3	03	37	1	3	04	18
2	2	00	44	2	2	01	26	2	2	02	27
Sub-		ſtile		Sub		ſtile		Sub		ſtile	
3	1	01	28	3	1	00	46	3	1	00	04
ii	x	03	41	ii	x	02	58	ii	x	02	14
1	3	05	56	1	3	05	10	1	3	04	27
2	2	08	12	2	2	07	25	2	2	06	40
3	1	10	31	3	1	09	43	3	1	08	55
iii	ix	12	53	iii	ix	12	03	iii	ix	11	13
1	3	15	41	1	3	14	28	1	3	13	36

(19)				(20)				(21)			
2	2	17	54	2	2	16	58	2	2	16	05
3	1	20	34	3	1	19	35	3	1	18	37
iv	viii	23	20	iv	viii	22	19	iv	viii	21	18
1	3	26	41	1	3	25	11	1	3	24	07
2	2	29	24	2	2	28	14	2	2	27	05
3	1	32	41	3	1	31	28	3	1	30	15
v	vii	36	15	v	vii	34	56	v	vii	33	38
1	3	40	04	1	3	38	38	1	3	37	14
2	2	44	07	2	2	42	37	2	2	41	08
3	1	48	30	3	1	46	54	3	1	45	18
vi		53	13	vi		51	30	vi		49	49
1	3	58	16	1	3	56	27	1	3	54	40
2	2	63	38	2	2	61	45	2	2	59	52
3	1	69	21	3	1	67	23	3	1	65	25
vii	v	75	21	vii	v	73	19	vii	v	71	17

South Declining. 22 00				*South Declining.* 23 00				*South Declining.* 24 00			
Hours		D.	M.	Hours		D.	M.	Hours		D.	M.
1	3	105	15	1	3	106	38	2	2	100	29
2	2	98	16	2	2	100	22	3	1	95	56
3	1	91	49	3	1	93	54	viii	iv	89	21
viii	iv	85	20	viii	iv	87	21	1	3	82	47
1	3	78	56	1	3	80	52	2	2	76	20
2	2	72	42	2	2	74	31	3	1	70	07
3	1	66	45	3	1	68	25	ix	iii	64	12
ix	iii	61	04	ix	iii	62	38	1	3	58	38
1	3	55	46	1	3	57	13	2	2	53	26
2	2	50	49	2	2	52	08	3	1	48	37
3	1	46	14	3	1	47	25	x	ii	44	08
x	ii	41	58	x	ii	43	03	1	3	39	49
1	3	38	01	1	3	39	00	2	2	36	11
2	2	34	20	2	2	35	16	3	1	32	37
3	1	30	55	3	1	31	46	xi	i	29	19

(22)			
xi	i	27	43
1	3	24	42
2	2	21	52
3	1	19	10
xii		16	36
1	3	14	07
2	2	11	44
3	1	09	26
i	xi	07	10
1	3	04	57
2	2	02	46
3	1	00	36
Sub-		ſtile	
ii	x	01	34
1	3	04	38
2	2	05	56
3	1	08	10
iii	ix	10	26
1	3	12	47
2	2	15	12
3	1	17	43
iv	viii	20	19
1	3	23	06
2	2	26	00
3	1	29	06
v	vii	32	24
1	3	35	53
2	2	39	43
3	1	43	48
vi		48	12
1	3	52	57
2	2	58	03
3	1	63	31
vii	v	69	18

(23)			
xi	i	28	31
1	3	25	28
2	2	22	35
3	1	19	51
xii		17	16
1	3	14	47
2	2	12	23
3	1	10	04
i	xi	07	49
1	3	05	37
2	2	03	26
3	1	01	16
Sub-		ſtile	
ii	x	00	52
1	3	03	01
2	2	05	09
3	1	07	26
iii	ix	09	39
1	3	11	57
2	2	14	23
3	1	16	47
iv	viii	19	21
1	3	22	03
2	2	24	52
3	1	27	55
v	vii	31	08
1	3	34	34
2	2	38	17
3	1	42	15
vi		46	33
1	3	51	12
2	2	56	12
3	1	61	34
vii	v	67	18

(24)			
1	3	26	12
2	2	23	17
3	1	20	32
xii		17	55
1	3	15	25
2	2	13	02
3	1	10	42
i	xi	08	27
1	3	06	15
2	2	04	04
3	1	01	53
Sub-		ſtle	
ii	x	00	13
1	3	02	20
2	2	04	30
3	1	06	40
iii	ix	08	54
1	3	11	09
2	2	13	29
3	1	15	54
iv	viii	18	25
1	3	21	04
2	2	23	51
3	1	26	48
v	vii	29	54
1	3	33	18
2	2	36	54
3	1	40	47
vi		44	59
1	3	49	31
2	2	54	25
3	1	59	07
vii	v	65	20
1	3	71	19

South Declining 25 00				*South Declining* 26 00				*South Declining.* 27 00			
Hours		*d.*	*m.*	*Hours*		*d.*	*m*	*Hours*		*d.*	*m.*
2	2	103	28	2	2	106	33	2	2	108	35
3	1	98	00	3	1	100	06	3	1	102	10
viii	iv	91	47	viii	iv	94	21	viii	iv	95	31
1	3	84	45	1	3	86	45	1	3	88	46
2	2	78	13	2	2	81	53	2	2	82	02
3	1	71	53	3	1	73	43	3	1	75	28
ix	iii	65	49	ix	iii	67	27	ix	iii	69	09
1	3	60	07	1	3	62	10	1	3	63	10
2	2	54	48	2	2	56	08	2	1	57	33
3	1	49	51	3	1	51	04	3	2	52	20
x	ii	45	16	x	ii	46	22	x	ii	47	31
1	3	41	02	1	3	42	02	1	3	42	50
2	2	37	08	2	2	38	02	2	2	38	58
3	1	33	30	3	1	34	19	3	1	35	12
xi	i	30	07	xi	i	30	53	xi	i	31	41
1	3	26	58	1	3	27	43	1	3	28	27
2	2	24	00	2	2	24	42	2	2	25	24
3	1	21	16	3	1	21	53	3	1	22	28
xii		18	33	xii		19	13	xii		19	51
1	3	16	04	1	3	16	02	1	3	16	39
2	2	13	39	2	2	13	37	2	2	14	14
3	1	11	20	3	1	11	19	3	1	12	31
i	xi	09	04	i	xi	09	40	i	xi	10	16
1	3	06	52	1	3	07	38	1	3	08	03
2	2	04	42	2	2	05	19	2	2	05	55
3	1	02	34	3	1	03	11	3	1	02	47
ii	x	00	02	ii	x	01	05	ii	x	01	40
Sub-		ſtlie.		Sub-		ſtile.		Sub-		-ſtile.	
1	3	01	40	1	3	01	01	1	3	00	23
2	2	03	47	2	2	02	33	2	2	02	28
3	1	05	58	3	1	05	15	3	1	04	34
iii	ix	08	08	iii	ix	07	24	iii	ix	06	42
1	3	10	22	1	3	09	35	1	3	08	51
2	2	12	41	2	2	11	51	2	2	11	09
3	1	15	03	3	1	14	11	3	1	13	22

(25)				(26)				(27)			
iv	viii	17	31	iv	viii	16	36	iv	viii	15	46
1	3	20	32	1	3	19	08	1	3	18	13
2	2	22	44	2	2	21	47	2	2	20	50
3	1	25	47	3	1	24	36	3	1	23	34
v	vii	28	47	v	vii	27	36	v	vii	26	29
1	3	32	03	1	3	30	47	1	3	29	36
2	2	35	34	2	2	34	13	2	2	32	57
3	1	39	29	3	1	37	54	3	1	36	32
vi		43	28	vi		41	54	vi		40	26
1	3	47	54	1	3	47	26	1	3	45	50
2	2	52	41	2	2	52	13	2	2	50	31
3	1	57	51	3	1	57	24	3	1	54	11
vii	v	63	24	vii	v	61	26	vii	v	59	33
1	3	69	18	1	3	67	16	1	3	65	19

South Declining. 28 00				*South Declining.* 29 00				*South Declining.* 30 00			
Hours		D.	M.	Hours		D.	M.	Hours		D.	M.
3	1	104	15	3	1	106	21	3	1	108	25
viii	iv	97	36	viii	iv	99	42	viii	iv	101	47
1	3	91	20	1	3	92	17	1	3	94	55
2	2	84	01	2	2	86	00	2	2	88	00
3	1	77	19	3	1	79	12	3	1	81	05
ix	iii	70	52	ix	iii	72	36	ix	iii	74	21
1	3	64	43	1	3	66	18	1	3	67	55
2	2	58	58	2	2	60	24	2	2	61	52
3	1	53	37	3	1	54	54	3	1	56	16
x	ii	48	40	x	ii	49	50	x	ii	51	00
1	3	44	07	1	3	45	09	1	3	46	12
2	2	39	56	2	2	40	52	2	2	41	48
3	1	36	04	3	1	36	55	3	1	37	46
xi	i	32	26	xi	i	33	16	xi	i	34	02
1	3	29	10	1	3	29	50	1	3	30	37
2	2	26	06	2	2	36	38	2	2	27	26
3	1	23	12	3	1	23	50	3	1	24	27

(28)				(29)				(30)			
xii		20	29	xii		21	05	xii		21	40
1	3	17	55	1	3	18	30	1	3	19	04
2	2	15	27	2	2	15	59	2	2	16	35
3	1	13	06	3	1	13	40	3	1	14	13
i	xi	10	51	i	xi	11	24	i	xi	11	57
1	3	08	38	1	3	09	12	1	3	09	44
2	2	06	30	2	2	07	03	2	2	07	36
3	1	04	04	3	1	04	58	3	1	05	32
ii	x	02	19	ii	x	02	54	ii	x	03	28
1	3	00	15	1	3	00	54	1	3	01	26
Sub-		ſtile.		Sub-		ſtile.		Sub-		ſtile.	
2	2	01	49	2	2	01	11	2	2	00	35
3	1	03	54	3	1	03	14	3	1	02	37
iii	ix	06	00	iii	ix	05	18	iii	ix	04	39
1	3	08	08	1	3	07	25	1	3	06	43
2	2	10	18	2	2	09	34	2	2	08	50
3	1	12	33	3	1	11	46	3	1	11	00
iv	viii	14	53	iv	viii	14	03	iv	viii	13	14
1	3	17	18	1	3	16	25	1	3	15	34
2	2	19	51	2	2	18	54	2	2	18	00
3	1	22	33	3	1	21	32	3	1	20	34
v	vii	25	23	v	vii	24	18	v	vii	23	16
1	3	28	25	1	3	27	16	1	3	26	09
2	2	31	41	2	2	30	29	2	2	29	15
3	1	35	11	3	1	33	51	3	1	32	34
vi		38	58	vi		37	32	vi		36	09
1	3	43	05	1	3	41	34	1	3	40	03
3	2	47	31	2	2	45	54	2	2	44	18
2	1	52	24	3	1	50	38	3	1	48	56
vii	v	57	39	vii	v	55	47	vii	v	53	58
1	3	63	19	1	3	61	20	1	3	54	25
2	2	69	22	2	2	67	19	2	2	65	19

South Declining 31 00				South Declining 32 00				South Declining. 33 00			
Hours		d.	m.	Hours		d.	m.	Hours		d.	m.
3	1	110	29	3	1	112	32	viii	iv	108	07
viii	iv	103	54	viii	iv	106	00	1	3	101	16
1	3	97	21	1	3	99	05	2	2	94	11
2	2	90	02	2	2	92	05	3	1	87	00
3	1	83	02	3	1	85	00	ix	iii	79	53
ix	iii	76	10	ix	iii	78	00	1	3	73	00
1	3	69	35	1	3	71	16	2	1	66	27
2	2	63	22	2	2	64	53	3	2	60	19
3	1	57	34	3	1	58	55	x	ii	54	39
x	ii	52	12	x	ii	53	25	1	3	49	27
1	3	47	17	1	3	48	21	2	2	44	42
2	2	42	46	2	2	43	43	3	1	41	00
3	1	38	38	3	1	39	29	xi	i	36	23
xi	i	34	50	xi	i	35	36	1	3	32	45
1	3	31	20	1	3	32	02	2	2	29	24
2	2	28	06	2	2	28	45	3	1	26	18
3	1	25	05	3	1	25	42	xii		23	25
xii		22	17	xii		22	51	1	3	20	43
1	3	19	38	1	3	20	11	2	2	18	16
2	2	17	08	2	2	17	40	3	1	15	47
3	1	14	45	3	1	15	16	i	xi	13	30
i	xi	12	28	i	xi	12	59	1	3	11	18
1	3	10	17	1	3	10	48	2	2	09	09
2	2	08	09	2	2	08	39	3	1	07	06
3	1	06	04	3	1	06	35	ii	x	05	05
ii	x	04	02	ii	x	04	34	1	3	03	11
1	3	02	01	1	3	02	34	2	2	02	08
2	2	00	01	2	2	00	35	Sub-		ſtile.	
Sub-		ſtlie.		Sub-		ſtile.		3	1	00	49
3	1	02	00	ε	1	01	24	iii	ix	02	47
iii	ix	04	01	iii	ix	03	24	1	3	04	46
1	3	06	03	1	3	05	24	2	2	06	46
2	2	08	08	2	2	07	27	3	1	08	50
3	1	10	15	3	1	09	32	iv	viii	10	57

(31)				(32)				(33)			
iv	viii	12	28	iv	viii	11	41	1	3	13	08
1	3	14	44	1	3	13	55	2	2	15	18
2	2	17	07	2	2	16	15	3	1	17	47
3	1	19	37	3	1	18	41	v	vii	20	17
v	vii	22	15	v	vii	21	15	1	3	22	58
1	3	25	04	1	3	22	00	2	2	25	49
2	2	28	04	2	2	26	56	3	1	28	52
3	1	31	18	3	1	30	04	vi		32	11
vi		34	48	vi		33	29	1	3	35	46
1	3	38	36	1	3	38	19	2	2	39	40
2	2	42	43	2	2	41	12	3	1	43	57
3	1	47	15	3	1	45	35	vii	v	48	38
vii	v	52	09	vii	v	50	24	1	3	53	09
1	3	57	31	1	3	55	38	2	2	59	21
2	2	63	19	2	2	61	20	3	1	65	25

South Declining. 34 00				*South Declining.* 35 00				*South Declining* 36 00			
Hours.		D,	M.	Hours		D.	M.	Hours		D.	M.
viii	iv	110	14	viii	iv	112	18	viii	iiii	114	22
1	3	103	25	1	3	105	27	1	3	107	40
2	2	96	19	2	2	98	25	2	2	100	34
3	1	89	04	3	1	91	17	3	1	93	12
ix	iii	81	50	ix	iii	83	47	ix	iii	85	46
1	3	74	48	1	3	76	37	1	3	78	26
2	2	68	04	2	2	69	42	2	2	71	21
3	1	61	46	3	1	63	14	3	1	64	41
x	ii	55	56	x	ii	57	13	x	ii	58	32
1	3	50	35	1	3	51	42	1	3	52	51
2	2	45	42	2	2	46	41	2	2	47	39
3	1	41	14	3	1	42	07	3	1	43	00
xi	i	37	10	xi	i	37	57	xi	i	38	43
1	3	33	28	1	3	34	09	1	3	34	50
2	2	30	03	2	2	30	41	2	2	31	18
3	1	26	54	3	1	27	29	3	1	28	03
xii		23	56	xii		24	31	xii		25	04

(34)			
1	3	21	16
2	2	18	42
3	1	16	17
i	xi	14	00
1	3	11	47
2	2	09	40
3	1	07	36
ii	x	05	36
1	3	03	38
2	2	01	41
Sub-		ſtile	
3	1	00	15
iii	ix	02	11
1	3	04	09
2	2	06	07
3	1	08	08
iv.	viii.	10	12
1	3	12	21
2	2	14	34
3	1	16	54
v.	vii.	19	21
1	3	21	57
2	2	24	43
3	1	27	10
vi.		30	54
1	3	33	57
2	2	38	11
3	1	42	20
vii	v	46	55
1	3	51	55
3	2	57	24
2	1	64	19

(35)			
1	3	21	46
2	2	19	12
3	1	16	46
i	xi	14	24
1	3	12	15
2	2	10	08
3	1	08	05
ii	x	06	06
1	3	04	08
2	2	02	19
3	1	00	18
Sub-		ſtile	
iii	ix	01	37
1	3	03	34
2	2	05	30
3	1	07	29
iv	viii	09	31
1	3	11	36
2	2	13	47
3	1	16	04
v	vii	18	27
1	3	20	58
2	2	23	40
3	1	26	34
vi		29	41
1	3	33	04
2	2	36	46
3	1	40	49
vii	v	45	15
1	3	50	18
2	2	55	30
3	1	61	21

(36)			
1	3	22	16
2	2	19	40
3	1	17	13
i	xi	14	54
1	3	12	42
2	2	10	35
3	1	06	32
ii	x	08	32
1	3	06	33
2	2	04	37
3	1	00	49
Sub-		ſtile	
iii	ix	01	05
1	3	02	58
2	2	04	53
3	1	06	50
iv	viii	08	49
1	3	10	52
2	2	13	00
3	1	15	13
v	vii	17	33
1	3	20	00
2	2	22	38
3	1	25	27
vi		28	29
1	3	31	46
2	2	35	21
3	1	39	17
vii	v	43	36
1	3	48	22
2	2	53	36
3	1	59	21

South Declining. 37 00				*South Declining.* 38 00				*South Declining.* 39 00		
Hours		D.	M.	Hours		Hours		D.	M.	D.
1	3	109	41	1	3	112	01	1	3	114
2	2	102	45	2	2	104	57	2	2	107
3	1	95	21	3	1	97	33	2	1	99
ix	iii	87	49	ix	iii	89	56	ix	iii	91
1	3	80	21	1	3	82	20	1	3	84
2	2	73	06	2	2	74	55	2	2	76
3	1	66	15	3	1	67	52	3	1	69
x	ii	59	53	x	ii	61	17	x	ii	62
1	3	54	02	1	3	55	15	1	3	56
2	2	48	42	2	2	49	46	2	2	50
3	1	43	52	3	1	44	49	3	1	45
xi	i	39	30	xi	i	40	18	xi	i	41
1	3	35	32	1	3	36	15	1	3	36
2	2	31	55	2	2	32	33	2	2	33
3	1	28	37	3	1	29	11	3	1	29
xii		25	35	xii		26	04	xii		26
1	3	22	29	1	3	23	15	1	3	23
2	2	20	08	2	2	20	36	2	2	21
3	1	17	40	3	1	18	07	3	1	18
i	xi	[illegible]	21	i	xi	15	47	i	xi	16
1	3	[illegible]	09	1	3	13	34	1	3	13
2	2	11	02	2	2	11	28	2	2	11
3	1	09	00	3	1	09	26	3	1	09
ii	x	07	01	ii	x	07	08	ii	x	07
1	3	05	05	1	3	05	34	1	3	05
2	2	03	12	2	2	03	41	2	2	04
3	1	01	20	3	1	01	50	3	1	02
Sub-		ſtile		Sub		ſtile		Sub		00
iii	ix	00	32	iii	ix	00	01	iii	ix	ſtile
1	3	02	24	1	3	01	52	1	3	01
2	2	04	17	2	2	03	53	2	2	03
3	1	06	13	3	1	05	35	3	1	05
iv	viii	08	10	iiii	viii	07	30	iiii	viii	06
1	3	10	10	1	3	09	28	1	3	08

(37)				(38)				(39)			
2	2	12	14	2	2	11	00	2	2	10	48
3	1	14	24	3	1	13	37	3	1	12	57
v	vii	16	41	v	vii	15	51	v	vii	15	01
1	3	19	40	1	3	18	09	1	3	17	18
2	2	21	38	2	2	20	39	2	2	19	49
3	1	24	21	3	1	23	18	3	1	22	17
vi		27	18	vi		26	09	vi		25	03
1	3	30	29	1	3	29	15	1	3	28	03
2	2	33	51	2	2	32	37	2	2	31	20
3	1	37	47	3	1	36	19	3	1	34	54
vii	v	42	00	vii	v	40	23	vii	v	38	51
1	3	46	36	1	3	44	53	1	3	43	14
2	2	51	43	2	2	49	52	2	2	48	05
3	1	57	21	3	1	55	21	3	1	53	27
viii	iiii	63	30	viii	iiii	61	24	viii	iiii	59	22

South Declining.				*South Declining.*				*South Declining*			
40 00				41 00				42 00			
Hours		D.	M.	Hours		D.	M.	Hours		D,	M:
1	3	116	16	2	2	111	31	2	2	113	45
2	2	111	57	3	1	104	09	3	1	106	17
3	1	101	56	ix	iii	96	22	ix	iii	98	02
ix	iii	94	16	1	3	88	15	1	3	90	31
1	3	86	20	2	2	79	18	2	2	82	28
2	2	78	35	3	1	72	38	3	1	74	37
3	1	71	10	x	ii	65	24	x	ii	67	12
x	ii	64	10	1	3	58	46	1	3	60	21
1	3	57	44	2	2	52	44	2	2	54	07
2	2	51	54	3	1	47	19	3	1	48	30
3	1	46	42	xi	i	42	27	xi	i	43	29
xi	i	41	53	1	3	38	06	1	3	37	52
1	3	37	37	2	2	34	10	2	2	34	58
2	2	33	46	3	1	30	36	3	1	31	19
3	1	30	16	xii		27	33	xii		28	01
xii		27	03	1	3	24	30	1	3	25	00

(40)

1	3	24	10
2	2	21	27
3	1	18	57
i	xi	16	36
1	3	14	22
2	2	12	16
3	1	10	14
ii	x	08	17
1	3	06	28
2	2	04	34
3	1	02	45
iii	ix	00	58
Sub-		ſtile	
1	3	00	49
2	2	02	38
3	1	04	27
iv	viii	06	17
1	3	08	10
2	2	10	07
3	1	12	08
v	vii	14	14
1	3	16	27
2	2	18	46
3	1	21	17
vi		23	59
1	3	26	21
2	2	30	03
3	1	33	31
vii	v	37	21
1	3	41	35
2	2	46	18
3	1	51	33
viii	iv	57	20

(41)

2	2	21	46
3	1	19	12
i	xi	16	53
1	3	14	37
2	2	12	35
3	1	10	34
ii	x	08	38
1	3	06	46
2	2	04	53
3	1	03	11
iii	ix	01	25
Sub-		ſtle	
1	3	00	21
2	2	02	07
3	1	03	54
iv	viii	05	42
1	3	07	32
2	2	09	26
3	1	11	24
v	vii	13	27
1	3	15	37
2	2	17	53
3	1	20	19
vi		22	57
1	3	25	42
2	2	28	48
3	1	32	10
vii	v	35	52
1	3	39	58
2	2	44	33
3	1	49	38
viii	iv	55	19
1	3	61	35

(42)

2	2	22	15
3	1	19	43
i	xi	17	22
1	3	15	03
2	2	12	59
3	1	10	59
ii	x	09	02
1	3	07	11
2	2	05	23
3	1	03	36
iii	ix	01	51
1	3	00	03
Sub-		ſtile	
2	2	02	34
3	1	03	22
iv	viii	05	08
1	3	06	57
2	2	08	43
3	1	10	42
v	vii	12	43
1	3	14	49
2	2	17	01
3	1	19	23
vi		21	54
1	3	24	38
2	2	27	37
3	1	30	33
vii	v	34	26
1	3	38	25
2	2	42	51
3	1	47	49
viii	iv	53	20
3	1	59	29

South Declining. 43 00				*South Declining.* 44 00				*South Declining.* 45 00			
Hours		D.	M.	Hours		D.	M.	Hours		D.	M.
ix	iii	100	54	ix	iii	103	10	ix	iii	105	29
1	3	92	45	1	3	94	56	1	3	97	23
2	2	84	31	2	2	86	29	2	2	88	39
3	1	76	28	3	1	78	10	3	1	80	25
x	ii	68	48	x	ii	70	15	x	ii	72	27
1	3	61	36	1	3	62	58	1	3	64	27
2	2	55	10	2	2	56	15	2	2	57	29
3	1	49	30	3	1	50	15	3	1	51	30
xi	i	44	19	xi	i	44	58	xi	i	45	58
1	3	40	00	1	3	40	12	1	3	40	57
2	2	35	34	2	2	35	58	2	2	36	36
3	1	31	46	3	1	32	13	3	1	32	44
xii		28	29	xii		28	55	xii		29	21
1	3	25	27	1	3	25	40	1	3	26	02
2	2	22	40	2	2	22	52	2	2	23	29
3	1	20	00	3	1	20	17	3	1	20	44
i	xi	17	34	i	xi	17	51	i	xi	18	19
1	3	15	21	1	3	15	25	1	3	15	59
2	2	13	14	2	2	13	34	2	2	13	58
3	1	11	29	3	1	11	35	3	1	12	00
ii	x	09	25	ii	x	09	41	ii	x	10	03
1	3	07	35	1	3	07	56	1	3	08	18
2	2	05	54	2	2	06	18	2	2	06	30
3	1	04	36	3	1	04	30	3	1	04	47
iii	ix	02	17	iii	ix	02	40	iii	ix	02	26
1	3	00	34	1	3	01	08	1	3	01	25
Sub-		ſtile		Sub		ſtile		Sub		ſtile	
2	2	01	07	2	2	00	46	2	2	00	15
3	1	02	51	3	1	02	34	3	1	01	53
iv	viii	04	38	iiii	viii	04	20	iiii	viii	03	34
1	3	06	24	1	3	06	00	1	3	05	15
2	2	08	15	2	2	07	40	2	2	06	59
3	1	10	04	3	1	09	28	3	1	08	30
v	vii	11	59	v	vii	11	20	v	viii	10	37
1	3	14	02	1	2	12	19	1	[illegible]	[illegible]	[illegible]

(43)				(44)				(45)			
2	2	16	11	2	2	15	19	2	2	14	03
3	1	18	28	3	1	17	37	3	1	16	10
vi		20	55	vi		19	56	vi		19	01
1	3	23	32	1	3	22	30	1	5	21	28
2	2	26	24	2	2	25	18	2	2	24	09
3	1	29	32	3	1	28	20	3	1	27	05
vii	v	33	02	vii	v	31	38	vii	v	30	20
1	3	36	52	1	3	35	26	1	3	33	54
2	2	41	10	2	2	39	33	2	2	37	56
3	1	45	58	3	1	44	14	3	1	42	26
viii	iv	51	22	viii	iv	49	29	viii	iv	47	31

South Declining 46 00				*South Declining* 47 00				*South Declining* 48 00			
Hours		*d.*	*m.*	*Hours*		*d.*	*m.*	*Hours*		*d.*	*m.*
3	1	116	39	1	3	117	57	1	3	117	06
ix	iii	108	50	ix	iii	109	00	ix	iii	112	36
1	3	99	34	1	1	101	51	1	3	104	21
2	2	90	58	2	3	93	21	2	1	95	35
2	1	86	20	3	2	84	25	3	2	86	35
x	ii	73	58	x	ii	75	56	x	ii	77	45
1	3	66	10	1	3	67	31	1	3	69	22
2	2	58	58	2	2	60	17	2	2	61	39
3	1	53	09	3	1	53	58	3	1	54	44
xi	i	46	49	xi	i	47	39	xi	i	48	36
1	3	41	41	1	3	43	22	1	3	43	19
2	2	37	18	2	2	37	51	2	2	38	28
3	1	33	19	3	1	33	50	3	1	34	18
xii		29	46	xii		30	11	xii		30	35
1	3	26	35	1	3	25	56	1	3	27	17
2	2	23	41	2	2	24	00	2	2	24	19
3	1	21	03	3	1	21	20	3	1	21	38
i	xi	18	37	i	xi	18	52	i	xi	19	09
1	3	16	21	1	3	16	23	1	3	16	53
2	2	14	15	2	2	14	32	2	2	14	47

(46)				(47)				(48)			
3	1	12	15	3	1	12	29	3	1	12	47
ii	x	10	21	i	x	10	37	ii	x	10	55
1	3	08	32	1	3	08	50	1	3	09	07
2	2	06	48	2	2	07	07	2	1	07	24
3	1	05	06	3	1	05	20	3	3	05	42
iii	ix	03	26	iii	ix	03	47	iii	ix	04	08
1	3	01	46	1	3	02	12	1	3	02	33
2	2	00	10	2	2	00	35	2	2	00	58
Sub-		ſtile.		Sub-		ſtile.		Sub-		ſtile.	
3	1	01	27	3	1	01	01	3	1	00	23
iv	viii	03	05	iv	viii	02	30	iv	viii	02	09
1	3	04	48	1	3	04	11	1	3	03	45
2	2	06	25	2	1	05	52	2	2	05	21
3	1	08	10	3	2	07	31	3	1	06	59
v	vii	09	57	v	vii	09	18	v	vii	08	42
1	3	11	49	1	3	11	06	1	3	10	28
2	2	13	46	2	2	13	01	2	2	12	19
3	1	15	52	3	1	15	00	3	1	14	16
vi		18	06	vi		17	11	vi		16	21
1	3	20	29	1	3	19	27	1	3	18	35
2	1	23	05	2	2	20	00	2	2	21	00
3	2	25	55	3	1	24	44	3	1	23	38
vii	v	29	00	vii	v	27	42	vii	v	26	32
2	3	32	30	1	3	31	34	1	3	29	45
2	2	36	32	2	2	35	00	2	2	33	21
3	1	40	43	3	1	39	00	3	1	37	24
viii	iv	45	38	viii	iv	43	54	viii	iv	41	54

South Declining 49 00				*South Declining* 50 00				*South Declining* 51 00			
Hours		*d.*	*m.*	*Hours*		*d.*	*m.*	*Hours*		*d.*	*m.*
ix	iii	115	10	ix	iii	117	22	ix	iii	118	00
1	3	107	46	1	3	109	14	1	3	111	43
2	2	97	50	2	2	91	08	2	2	100	52
3	1	88	53	3	1	81	48	3	1	93	27

(49)				(50)				(51)			
x	ii	79	43	x	ii	81	48	x	ii	83	15
1	3	71	04	1	3	72	49	1	3	74	57
2	2	63	02	2	2	64	30	2	2	65	59
3	1	55	47	3	1	57	02	3	1	58	14
xi	i	49	30	xi	i	50	15	xi	i	51	20
1	3	43	52	1	3	44	40	1	3	45	22
2	1	39	03	2	2	39	35	2	2	40	07
3	3	34	46	3	1	35	13	3	1	35	40
xii		30	58	xii		31	21	xii		31	45
1	3	27	36	1	3	27	55	1	3	28	13
2	2	24	36	2	2	24	52	2	2	25	03
3	1	21	54	3	1	22	07	3	1	22	18
i	xi	19	23	i	xi	19	36	i	xi	19	49
1	3	17	02	1	3	17	20	1	3	17	32
2	2	14	59	2	2	15	11	2	2	15	25
3	1	13	01	3	1	13	14	3	1	13	25
ii	x	11	13	ii	x	11	27	ii	x	11	36
1	3	09	20	1	3	09	46	1	3	09	57
2	2	07	40	2	2	07	57	2	2	08	12
3	1	06	21	3	1	06	27	3	1	06	41
iii	ix	04	30	iii	ix	04	54	iii	ix	04	59
1	3	02	53	1	3	03	12	1	3	03	30
2	2	01	19	2	2	01	41	2	2	01	59
Sub-	ſtile			3	1	00	10	3	1	00	35
3	1	00	15	Sub-	ſtile			Sub-	ſtile		
iv	viii	01	47	iv	viii	01	19	iv	viii	00	58
1	3	03	18	1	3	02	50	1	3	02	25
2	2	05	00	2	2	04	22	2	2	03	45
3	1	06	27	3	1	05	56	3	1	05	27
v	vii	08	00	v	vii	07	32	v	vii	07	00
1	3	09	49	1	3	09	12	1	3	08	36
2	2	11	37	2	2	10	57	2	2	10	18
3	1	13	32	3	1	12	47	3	1	12	05
vi		15	32	vi		15	03	vi		14	04
1	3	17	42	1	3	16	49	1	3	15	59
2	2	20	01	2	2	19	03	2	2	18	08
3	1	23	01	3	1	21	30	3	1	20	29
vii	v	25	37	vii	v	24	11	vii	v	23	02

(49)				(50)				(51)			
1	3	28	27	1	3	27	10	1	3	25	59
2	2	31	55	2	2	30	29	2	2	27	07
3	1	35	49	3	1	34	14	3	1	32	43
viii	iv	40	11	viii	iv	37	56	viii	iv	36	56

South Declining 52 00				*South Declining* 53 00				*South Declining.* 54 00			
Hours		*d.*	*m.*	*Hours*		*d.*	*m*	*Hours*		*d.*	*m.*
1	3	117	21	1	3	118	10	1	3	119	08
2	2	106	27	2	2	108	05	2	2	110	46
3	1	96	57	3	1	98	30	3	1	101	06
x	ii	86	09	x	ii	88	35	x	ii	90	46
1	3	76	27	1	3	78	29	1	3	80	40
2	2	67	29	2	2	69	30	2	2	71	00
3	1	59	22	3	1	60	40	3	1	62	05
xi	i	52	10	xi	i	55	20	xi	i	56	26
1	3	45	54	1	3	46	41	1	3	48	15
2	2	40	40	2	2	41	10	2	2	42	30
3	1	35	58	3	1	36	30	3	1	37	45
xii		32	05	xii		32	26	xii		32	46
1	3	28	24	1	3	28	39	1	3	28	56
2	2	25	13	2	2	25	25	2	2	25	40
3	1	22	24	3	1	22	36	3	1	22	50
i	xi	19	53	i	xi	20	12	i	xi	20	22
1	3	17	38	1	3	17	45	1	3	17	56
2	2	15	30	2	2	15	41	2	2	15	49
3	1	13	35	3	1	13	43	3	1	13	59
ii	x	11	48	ii	x	11	57	ii	x	12	06
1	3	10	00	1	3	10	08	1	3	10	21
2	2	08	21	2	2	08	38	2	2	08	43
3	1	06	44	3	1	07	00	3	1	07	10
iii	ix	05	18	iii	ix	05	31	iii	ix	05	44
1	3	03	47	1	3	04	18	1	3	04	15
2	2	02	18	2	2	02	35	2	1	02	52
3	1	00	52	3	1	01	11	3	2	01	30
Sub-		ſtlie.		Sub-		ſtile.		viii	iiii	00	07

(52)				(53)				(54)			
iv	viii	00	34	vi	viii	00	12	Sub-		ſtle	
1	3	02	00	1	3	01	36	1	3	01	14
2	2	03	28	2	2	03	02	2	2	02	37
3	1	04	46	3	1	04	32	3	1	04	00
v	vii	06	28	v	vii	05	56	v	vii	05	28
1	3	08	03	1	3	07	27	1	3	06	55
2	2	09	40	2	2	09	03	2	2	08	27
3	1	11	23	3	1	10	46	3	1	10	03
vi		13	13	vi		12	26	vi		11	46
1	3	15	10	1	3	14	17	1	3	13	35
2	2	17	18	2	2	16	18	2	2	15	30
3	1	19	30	3	1	18	13	3	1	17	36
vii	v	22	00	vii	v	20	53	vii	v	19	50
1	3	24	44	1	3	23	30	1	3	22	23
2	2	27	53	2	2	26	26	2	2	25	13
3	1	31	01	3	1	29	42	3	1	18	20
viii	iv	35	34	viii	iv	33	33	viii	iv	32	00

South Declining 55. 00				*South Delining* 56. 00				*South Declining* 57 00.			
Hours.		*d.*	*m.*	*Hours*		*d.*	*m.*	*Hours*		*d.*	*m.*
1	3	120	02	1	3	122	20	1	3	124	10
2	2	113	20	2	2	116	02	2	2	118	58
3	1	103	34	3	1	106	32	3	1	109	24
x	ii	93	24	x	ii	96	13	x	ii	98	55
1	3	82	55	1	3	85	20	1	3	87	56
2	2	72	47	2	2	74	52	2	2	76	58
3	1	63	30	3	1	65	13	3	1	66	47
xi	i	55	25	xi	i	56	40	xi	i	57	50
1	3	48	21	1	3	49	20	1	3	50	10
2	2	42	22	2	2	43	02	2	2	43	40
3	1	37	18	3	1	37	50	3	1	38	12
xii.		33	06	xii		33	24	xii		33	42
1	3	29	10	1	3	29	21	1	3	29	28
2	2	25	52	2	2	26	01	2	2	26	15

(55)				(56)				(57)			
3	1	22	57	3	1	23	05	3	1	23	10
i	xi	20	23	i	xi	20	30	i	xi	20	33
1	3	18	04	1	3	18	10	1	3	18	16
2	2	15	56	2	2	16	03	2	2	16	09
3	1	14	00	3	1	14	10	3	1	14	15
ii	x	12	13	ii	x	12	17	ii	x	12	21
1	3	10	30	1	3	10	40	1	3	10	42
2	2	08	53	2	2	09	07	2	2	09	10
3	1	07	22	3	1	07	31	3	1	07	35
iii	ix	05	53	iii	ix	06	00	iii	ix	06	08
1	3	04	30	1	3	04	43	1	3	04	45
2	2	03	07	2	2	03	22	2	2	03	33
3	1	01	45	3	1	02	02	3	1	02	18
iv.	viii.	00	26	iv	viii	00	41	iv	viii	01	02
Sub-		ſtile		Sub-		ſtile		Sub-		ſtile	
1	3	00	54	1	3	00	34	1	3	00	14
2	2	02	14	2	2	01	53	2	2	01	30
3	1	03	35	3	1	03	12	3	1	02	47
v.	vii.	04	02	v	vii	04	33	v	vii	04	06
1	3	06	26	1	3	05	55	1	3	05	26
2	2	07	57	2	2	07	22	2	2	06	49
3	1	09	26	3	1	08	50	3	1	08	15
vi.		11	05	vi		10	24	vi		09	44
1	3	12	51	1	3	12	09	1	3	11	22
2	2	14	38	2	2	13	50	2	2	13	08
3	1	16	38	3	1	15	45	3	1	14	57
vii	v	18	50	vii	v	17	52	vii	v	16	35
1	3	21	16	1	3	20	10	1	3	19	10
2	2	24	01	2	2	22	43	2	2	21	38
3	1	27	02	3	1	25	37	3	1	24	22
viiii	iv	30	30	viii	iv	28	54	viii	iv	27	30

South Decli. 58 00

Hours		*d*	*m.*
2	2	122	10
3	1	113	18
x	ii	102	38
1	3	91	23
2	2	79	08
3	1	69	20
xi	i	60	10
1	3	51	10
2	2	44	20
3	1	38	39
xii		34	00
1	3	29	50
2	2	26	20
3	1	23	20
i	xi	20	39
1	3	18	23
2	2	16	13
3	1	14	18
ii	x	12	30
1	3	10	56
2	2	09	18
3	1	07	49
iii	ix	06	26
1	3	05	04
2	2	07	46
3	1	02	31
iv	viii	01	16
1	2	00	02
Sub-		ſtile	
2	2	01	10
3	1	02	25
v	vii	03	41
1	3	04	58
2	2	06	20
3	1	07	43
vi		09	10
1	3	10	43
2	2	12	22
3	1	14	08
vii	v	16	03
1	3	18	08
2	2	20	30
3	1	23	10

South Decli. 59 00

Hours		*d.*	*m*
3	1	114	02
x	ii	104	40
1	3	94	07
2	2	81	26
3	1	70	20
xi	i	60	28
1	3	51	57
2	2	44	56
3	1	38	58
xii		34	17
1	3	55	54
2	2	26	30
3	1	23	20
i	xi	20	38
1	3	18	17
2	2	16	10
3	1	14	13
ii	x	12	30
1	3	10	53
2	2	09	20
3	1	07	55
iii	ix	06	35
1	3	05	15
2	2	03	58
3	1	02	45
iv	viii	01	31
1	3	00	19
Sub-		ſtile	
2	2	00	52
3	1	02	05
v	vii	03	18
1	3	04	33
2	2	05	40
3	1	07	10
vi		08	35
1	3	10	03
2	2	11	37
3	1	13	18
vii	v	15	09
1	3	17	10
2	2	19	23
3	1	21	56
viii	iv	24	46

South Decli. 60 00

Hours		*d.*	*m.*
3	1	119	20
x	ii	108	40
1	3	96	17
2	2	84	15
3	1	82	40
xi	i	61	53
1	3	52	10
2	2	45	35
3	1	39	27
xii		34	33
1	3	30	08
2	2	26	27
3	1	23	23
i	xi	20	41
1	3	18	20
2	2	16	11
3	1	14	16
ii	x	12	31
1	3	10	53
2	2	09	24
3	1	07	58
iii	ix	06	39
1	3	05	23
2	2	04	07
3	1	02	55
iv	viii	01	42
1	3	00	33
Sub-		ſtile	
2	2	00	34
3	1	01	25
v	vii	02	56
1	3	04	08
2	2	05	23
3	1	06	40
vi		08	02
1	3	09	26
2	2	10	57
3	1	12	36
vii	v	14	20
1	3	16	15
2	2	18	22
3	1	20	45
viii	iv	23	28

The Second Part.

Arithmetical And Inſtrumental } DIALLING.

YOU have here the making of all ſorts of *Dials* Arithmetically, by Artificial Sines, and *Tangents*: And Inſtrumentally by a Ruler in page 62 of the *firſt* Chapter; I think I need not tell you what the Ruler is, nor what Lines are upon it, for they are known to every one that underſtands the Letter that ſtands at the beginning of each Lines; and therefore I ſhall ſay no more of this Ruler as to the deſcription of it.

How to make an *Equinoctial Dial.* *Fig*. 20.

Draw two Parallell Lines, as C, E, D, and A, F, B, and in the middle of the *Plane*, draw the *Perpendicular* F E, for the Hour of 12; then take from your Polar Scale (either of them will do) 1, 2, 3, 4, and 5 Hours ſucceſſively one after another, and place from 12 on the parallell Lines, from E, and F, toward C, and D, and A B, and Lines drawn from one point to the other, are the Hour-lines required.

The *S*tiles height is the diſtance between 12 and 3.

The Second PART.

CHAP. I. *Fig.* 10.

How to make a Polar Dial.

A *Polar Dial* is a *Dial* that lieth upon the Equinoctial Circle, whoſe Stile or Axis is 90 deg. high, or (more properly ſpeaking) is Perpendicular to the *Plane*, and is the eaſieſt to be made of any *Dial* whatſoever; for the Equinoctial Circle being divided into 360 deg. one 24 part is 15 deg. or one Hour; this *Dial* being an *Horizontal Dial* under the Poles of the World, where the Sun is ſaid to move equal ſpace in equal time; but the Shadow in all other places is Irregular.

Therefore the making of this *Dial* is nothing but dividing a Circle into 24 equal parts, and ſetting up an Iron Pin perpendicular to it's *Plain*, your *Dial* is finiſhed.

And this *Plane*, or *Dial* is Capable of receiving all the 24 Hours, in the Latitude of 90 deg. Becauſe the Sun keepeth continually moving round it, and round it again for the ſpace of almoſt half a Year: And in all other Latitudes according to the Length of their Days: So in our Latitude are put on all the Hours from 4 in the Morning till 8 at Night.

But the making of this *Dial* according to Geometrical Rule is laid down in the 7 Chapter in Page 21.

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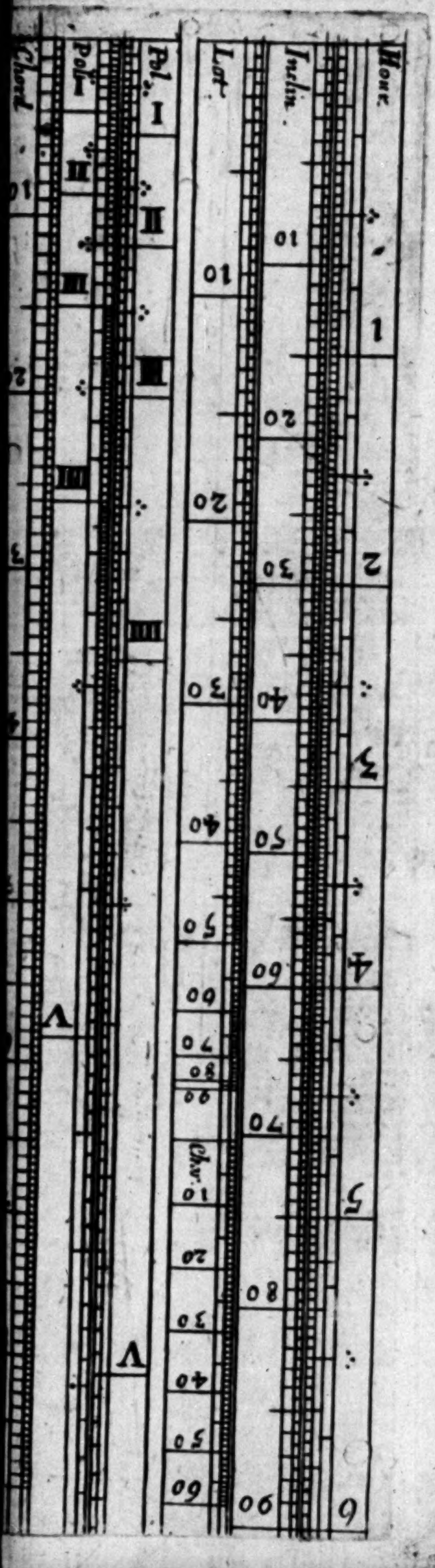


Hour
Inclin.
Lat
Chor.
Pol.
I
II
III
IIII
V
Pol.
II
III
IIII
V
Chord

CHAP. II.

Of [Vetrical *or*] Horizontal *Planes*. ARITHMRTICALLY.

IN theſe Planes there is nothing required but the *Height of the Pole above the Plane*, which in all places, is equal to the Latitude of the place, for which the *Dial* is made.

Firſt, therefore prepare a Table, according to the Example adjoyning, wherein ſet down all the Hours in order from 12, as they are equidiſtant from the Meridian, *viz.* 11 and 1, 10 and 2, 9 and 3, 9 *&c.* unto them Adjoyn the Equinoctial diſtances, that is, for the firſt Hour 15 degrees, for the ſecond Hour 30 deg. for the Third Hour 45 deg. and ſo of the reſt, by continual addition of 15 deg. then take out of your Canon [or Tables] upon a looſe paper, the Logarithm or Artificial Sign of the Elevation of the Pole above this Plane, which for 51 d. 30 m. The height of the Pole here at *London*, is 9.893544, and is always one of the middle Proportionals, in finding out every Hours diſtance, apply it to 9.428052, the Logar. tangent of 15 deg. [which is the firſt Hours Equinoctial diſtance] and add them both together, there ſhall come forth a new Logar. tangent of 19.321596, for that Hours diſtance, which ſet down in the Table by 15 d. in the ſame place, remove your Paper, to the Logar. tangent of 30 deg. and add them both together, you ſhall produce a new Logar. tangent of 19.893544, for the Hour of 2 and 10, which ſet down in the Table by 30 deg. Work after the ſame

manne

manner, with the Logar. Tangent of 45, 60, 75, deg. for the reſt of the Hours.

Hours		*Equinoctial diſtances.*	*The Logarithm of the Tangents.*	*The new Logar. of the Tangents.*	*The tru hour diſtances upon the Plane.*
XII.		ᵈ0 0′.	0	0	
XI	I	15. 0.	9.4280052.	19.321596.	0ᵈ 0′
X	II	30. 0.	9.761439.	19.654982.	11. 50
IX	III	45. 0.	10.0000000	19.893544.	24. 19
VIII	IIII	60. 0.	10.238561	10.132105.	38. 3
VII	V	75. 0.	10.571947	10.465491.	53. 36
VI •		90. 0.	Infinite.	Infinite.	71. 6.
					90. 0

The height of the Stile 51. 30.

The Canon for Calculation is,
As the Sign of 90 deg.
Is to the Sign of the *Latitude*, 51 deg. 30 min.

So is the *Tangent* of 15 deg. [the *Fquinoctial Diſtance* of *One* Hour; of 30 deg. for *Two* Hours; of 45 deg. for *Three* Hours, *&c.*]

To the *Tangent* of 11 deg. 50 min. for 11 and 1— of 24 deg. 20 min. for 10 and 2—of 38 deg. 3 min. for 9 and 3, *&c.*

Now if you deſign to put into this Dial, or any of the reſt that follow, the half Hours and Quarters, their diſtances upon the Plane are as eaſily found by the ſame Rules, as the Hours were, for by adding the Log. Sign of the height of the Pole, or Stile, unto the Log. Tangents of

3 deg. 45 min. 7 deg. 30 min. and 11 deg. 15 min. which are the Equinoctial diſtances of alf Hours and quarters, there will come forth he Log. Tangents of new diſtances, proper to he halfs and quarters. *Note* there is a Table of Equinoctial diſtances for Hours halfs and quarters n Page 31.

Note. Thus you have all the Hour-lines; but or the Drawing of it take the Directions of the Chapter, in Page 15.

CHAP. III.

How to draw the Hour-lines *upon a Direct* South Dial *in the* Lat. *of* 51 *deg.* 30 *min.*

IT is almoſt needleſs to ſay any thing concerning the marking of a Direct *South* Dial, for here is but little difference between it and the Horizontal, only you muſt take notice that this *Plane* reſpecteth the *South* Pole, which Pole is levated thereon 38 deg. 30 min. (always) the Complement of the *Latitude*, therefore take 38 eg. 30 min. out of your *Scale* of Latitudes, and niſh your *Dial* in all reſpects as you did the Horizontal: but obſerve, that whereas in that *Dial*, the Hours of 1, 2, 3, &c. where ſet off on our *Left-hand* of the *Meridian*, ſo the ſame Hours muſt in this *Dial* be ſet off on your Right-Hand of the *Meridian*; if you well obſerve what was ſaid in the IX*th* Chapter, Page 24

Note, That the *Angle* which the *Stile* makes with the *Meridian*, muſt (as I have ſaid before) be 38 deg. 30 min.

2. And Laſtly, that the *Stile* muſt ſtand at right *Angles* with the Plane.

CHAP. IV.

Concerning a direct North Dial.

A Direct *North* Dial, is the ſame with the *South*, only the Stile muſt point upwards toward the *North* Pole, and the hours about Mid-night, as 9, 10, 11, 12: 1, 2, and 3 muſt be left out, and 4 and 5 in the Morning, aud 7 and 8 at Night muſ be drawn thro' the *Center*, as in the *Horizonta* Dial: So is your *North* Dial finiſhed.

SECT. I. *Fig.* 1

How to draw an Horizontal Dial, *for the* Latitud *of* 51. 30. *by the* Scale *of* Laritude, *and the Inclinotion of the Meridian.*

D 1. Draw the line A B, for 6 a Clock Mon ing and Evening.

2. Draw NS, *Perpendicular* to A B; this lin ſhall be the Meridian, or 12 a Clock Hour-line.

3. Let C, the interſection of the foreſaid lin be the Center of the *Dial*; then repair to you Scale of Latitudes, and fixing one foot of you Compaſſes at the beginning, extend the other t 51 deg. 30 min. and ſet that from C to A, an from C to B, then open your Compaſſes th whole length of the line of *Inclination*, or the Scal of 90 deg. ſetting that extent one Foot in A, mov the other till it meet with the Meridian-line N as at O, and draw the line A O, and B O.

4. This done, extend your Compaſſes from th

b

beginning of your Scale of 90 deg. to 15 deg. and ſet from O towards A and B, for the Hours of 11 and 1, alſo from A towards O, for 5 a Clock and from B towards O, for 7 a Clock. Then extend your Compaſſes from the beginning of your Scale to 30 deg. and ſet from O towards A, and B, for the Hours of 2 and 10, Likewiſe from A towards O, for 4, and from B, towards O, for 8 of the Clock. Then take 45 deg. and ſet from O, toward A, and B, for the Hours of 3, and 9, ſo you have 12 Points for Hours. Now Lines drawn from the Center C, to each of thoſe Points ſhall be the Hours required.

Note. That the Hours of 4 and 5 in the Morning, and 7 and 8 in the Evening, muſt be drawn thro' the Center C; and if you deſign the halfs and quarters of an Hour on your *Dial*, obſerve what was ſaid in the laſt Chapter.

2. With a Line of Chord, make an Angle of 51.30. for the Stile of your *Dial*, and ſet it over the Meridian-line CO at right Angle, and your *Dial* is finiſhed.

CHAP. V. *Fig.* 21.

How to draw Hour-lines upon a *South* or *North Dial* Declining either *Eaſt* or *Weſt* to any Declination.

BEFORE the Hour-lines can be drawn upon any of thoſe *Planes* two things muſt be given, and three other things muſt be found.

The things given are;

1. The *Latitude* of the Place,

2. The

2. The *Planes Declination*,

The things that muſt be found are,

1. The Subſtiles Diſtance from the *Meridian* or 12 a Clock Hour-line.
2. The height of the Stile above the *Plane*.
3. The *Planes* difference of Longitude.

Example, Suppoſe that in the *Latitude* of *London* 51. 30. it where required to draw a *Dial* 25 deg. of *Declination Weſtwards*.

The Canon for Calculation are,

As the Radius ——— ——— ——— 90: 00—10.000000
Is to the Sign of the *Declinat*. 25:00—9.625948
So is the Co-Tangent of the *Lat*. .51:30—9.900605

To the Tan. of the Sub. diſt. 18:33—19.525653

As the Radius ——— ——— ——— 90:00—10.000000
Is to the Co.Sign of the *Decli*. 25:00—9.957276
So is the Co-ſign of the *Latitude*. 51:30—9.794149

To the ſign of theStiles height, 34:21—19.751425

As the Radius, ——— ——— ——— 90:00—10.000000
Is to the Co-Tang. of the *Decli*. 25:00— 10.331327
So is the Sign of the *Latitude*. 51:30— 9.893544

To the Co-Tang. of the *Planes* 30:47—10.225871
Long.

Having

Hour on the Dial		Equinoctial Diſtances.		True Hours diſtance from the Subſtile	
East	West	D.	m.	D.	M.
III.	IX.	75	47	65	49
II.	X.	60	47	45	16
I.	XI.	45	47	30	07
XII.		30	47	18	33
XI.	I.	15	47	09	04
X.	II.	00	47	00	02
Subſtile		*Subſtile*		*Subſtile*	
IX.	III.	14	13	08	08
VIII.	IIII.	29	13	17	31
VII.	V.	44	13	28	47
VI.		59	13	43	28
V.	VII.	74	13	63	04
IV.	VIII	89	13		07

Having proceeded, thus far prepare a Table of Hours fit for the *Plane*, ſuch as is here done.

Then againſt XII. ſet the *Planes* Differences of Longitude 30 deg. 47 min. (in the ſecond Column) and from it ſubtract 15 deg. and their will remain 15: 47. which ſet againſt XI. and I. Then Subtract 15 and there will remain only 47 min. which ſet againſt and II. Then becauſe 47 min. is leſs than 15 deg. write the word Subſtile under it, and Subtract it from 15 deg. their will remain 14 deg. 13 min. which ſet againſt IX and III. Then to 14 deg. 13 min. add 15 deg. it maketh 29: 13. which ſet againſt VIII. and IV. Then add 15 deg. it maketh 44: 47 which ſet againſt VII and V. Then add 15 and it makes 59: 47. which ſet againſt VI. then 15 more makes 74. 47 which ſet againſt V. and VII. Then 15 more makes 89: 47. having finiſhed your Table on this ſide of 12 a Clock, I begin begin again at 12 and add 15 it makes 45: 47. which ſet againſt I. and XI.

and 15 more makes 60: 47 which ſet againſt II. and X. and 15 more makes 77: 47. which ſet againſt III. and IX. And thus you have made a Table fit for Calculation, *viz.* for finding the true Hour-diſtances on the *Plane*.

The Canon for Calculation is,

As the Radius, ———— 90: 00—10.000000
Is to the ſign of the Stiles height, 3421—9.751499
So is the *Tan.* of the *Equi.* diſt. 14:13—9.403718

To the *Tangent* of, —— 08:08—19.155187

Which is the Diſtance of 9 and 3 of the Clock from the Subſtile.

And ſo will the *Tangent* of the next *Equinoctial* diſtance, 29 : 13. be to the *Tangent* of 17 : 31. for the diſtance of the Hour-line of 8, and 4. from the Subſtile, and ſo for all the reſt of the Hours, as in the Table.

Having Calculated all your Hour: you have directions for deſcribing them on the *Plane*, by CHAP. V. In Page 19.

SECT. I.

How to draw Hour-lines on *South* and *North* Declining *Planes* by your Line of *Latitude* and Inclination of *Meridian* on your Ruler in Page 62.

An *Example* of the foregoing *Dial*, *Decl.* 25 deg.

HAving Calculated your Requiſites belonging to your *Dial*, and made a Table of

Equinoctial Diſtances, according to the former part of this Chapter, you will find them to be as followeth,

To draw the *Dial.*

Latitude.	51 : 30
Pl. Decli.	25 : 00
Sub. Diſt.	18 : 33
Stiles hei.	34 : 21
Plan. long.	30 : 47

Hours	*Equinoct.*	
	d.	*m*
IX.	75	47
X.	60	47
XI.	45	47
XII.	30	47
I.	15	47
II.	00	47
Sub-	ſtile.	
III.	14	13
IV.	29	13
V.	44	13
VI.	59	13
VII.	74	13
VIII.	89	13

1. Draw an *Horizontal* Line on the *Plane.*

2. Draw C 12, the *Meridian*, or 12 a Clock Hour-line, *Perpendicular* to the *Horizontal* line of your *Plane*, and with a line of Chords make the Angle F C 12. equal to the Subſtiles diſtance from the *Meridian*, and draw C F for the Subſtile on the Right-Hand of the *Meridian* becauſe the *Plane Declines Weſt.*

3. Draw the Line A B, *Perpendicular* to the Subſtile, and paſſing thro the Center at C, then out of your line of *Latitude* take 34 : 21 (the height of your Stile) and ſet from C to A, and from C to B, then take in your Compaſſes the whole length of your Scale of *Inclination* of *Meridian*, and ſet one Foot in A, and turn the other about till it will touch the Subſtilar line, as at F, and draw the Line F A, and F B.

4. Then repair to your Table, and take off your Scale of *Inclination* of *Merid.* 15 deg. 47 min.

30 : 47, 45 : 47, 60 : 47, 75 · 47, and ſet from F the Subſtile towards A, for the Hours of 2, 1 12, 11, 10, and 9 of the Clock; again take 14 : 13, 29 : 13, 44 : 13, 59 : 13, 74 : 13, and 89 : 13, and ſet from F, towards B, for the Hours of 3, 4, 5, 6, 7, and 8, *Note*, 8 falling above the *Horizontal-line*, is drawn thro' the Center for 8 in the *Morning*, as you ſee in the Figure.

5. Let your *Hour-lines* be drawn from the Center thro' every mark in the Line F A, and F B, and your Stile ſet on the Subſtile, making an Angle of 34 : 21. and your *Dial* is finiſhed.

SFCT. II.

How by the heigth of the Stile, the *Declination* of the *Sun*, to find what time the *Sun* ſhall part, from one ſide of a *Declining Plane* to the other.

The Canon for Calculation,

As the Radius,———————— 90:00—10.00000
Is to the *Tang.* of the *Sun's Decl.* 23:30—9.63830
So is the *Tang.* of the Stiles height. 34:21—9.83469

To this Co-ſine, *viz.* 72 : 43—19.47299

From which Subtract the *Planes Long.* —— 30 : 47
And there remains, 41 : 56

Which 41 : 56 reſolved into time (by allowing 15 deg. to one Hour, and the odd deg. 4 min. of time,) maketh 2 Hours 48 min. afternoon, that the *Sun* forſaketh the *South Dial De-*

clining

lining Eaſt, to ſhine upon the *North Dial Declining Weſt*: So by the ſame Calculation the *Sun* orſaketh the *North Declining Eaſt* 2 Hours 8 min. before Noon, to Shine upon the *South Declining Weſt*.

Again the *Sun* being in ♑, the *Southern* Sine unto ———————————— 72 : 43
Add the *Planes Longitude* ——— ——— 30 47

102 : 90

The *Sum* is, ——— ——— ——— 103 : 30

Whoſe Complement to 180 deg. is, 76 : 30

Which converted into time is 5 Hours 6 min. for the time in Capricorn, when the *Sun* paſſeth from one ſide of the *Plane* to the other, between which two Limets the Annual variety of the *Sun* is concluded.

Laſtly, in the making of this *Dial* you have made four, *viz.* Firſt a *South Declining Weſt* 25 deg. but if you turn your Paper and look thro' it, it will on the Back-ſide be a *South Declining Eaſt*, 25 deg. Only the Afternoon Hours on the *Weſt Dial*, muſt be the Morning Hours on the *Eaſt*, and if you turn your *Dial* the bottom upwards and reckon your Hours the contrary way: So a *South Eaſt Decliner*, will be a *North Eaſt Decliner*, and a *South Weſt Decliner*, will be a *North Weſt Decliner*, leaving out the *Hour-lines*, [which will be neeedleſs] before the *Sun-ſetting* and after the *Sun-riſing*.

Note, that the Subſtile in all *Decliners*, goeth from the *Meridian* towards that Coaſt, which is contrary to the Coaſt of the *Planes Declieation*.

CHAP. VI. *Fig.* 22.

How to draw Hour-lines *upon a* Far *Declining* Dial, *by the two* Polar Scales *on the* Ruler.

Example of a South Dial Declining Eaſt 80 *deg. in the Latitude of* 51 *deg.* 30 *min.*

BY the directions of the laſt *Chapter*, (or by the *Table* page the *26th*) you ſhall find the *Inclination* of the *Meridian* to be 82 deg. 9 min. and the height of the *Stile* above the *Plane* 6 deg. 12 min. and the *Subſtile's* diſtance from the *Meridian* 38 deg. 4 min.

Proceed thus, draw firſt, the Perpendicular GH, then with the *Radius* of your line of *Chords*, deſcribe the Arch L M, and ſet off the Subſtile and Stile with the ſame line of *Chords*, according to their reſpective Angles, and draw the pricked line CBA for the *Subſtile*; and GIK for the *Stile*.

Then chooſe any point in the *Subſtile*, as A, through which point A, draw a line at length, Perpendicular to it, as the line EAC, that done, fix one foot of your Compaſſes at the beginning of your longeſt *Polar Scale*, and extend the other to the *Hour* of 3, ſet off this extent from A to C, and through the point C draw a line Parallel to the *Stile* GIK, as the line C D, ſo ſhall C D be the *Stile* increaſed. Then open your Compaſſes from the beginning of your ſecond or leſſer *Polar Scale*, to 3 *Hours*, and with that extent, place one foot of your Compaſſes in the *Subſtile* ABG, carrying g it along the ſaid line, until the other foot of he Compaſſes juſt touch the line C D, and there ake a mark, as at B, through which mark B, raw a line at length, and Parall to the line EAC, s the line D B F. Then conſidering the *Incli-* *ation* of the *Meridian* was found to be 82 deg. min. find it on the ſecond *Sale*, or *Seale* of 90 deg. nd againſt it on the firſt *Scale* you ſhall find 5 *ours* 29 *Minutes*, by which it appears that the *ubſtile* falleth between the *Hours* of 6 and 7 in he *Morning*.

Now according to the *Inclination* of *Meridians* *Hours* 29 *Minutes*, you may proceed to make *Table*, and ſet off the *Hours* accordingly, as olloweth.

Open your Compaſſes to 00 *Hours* 29 min. of he greater *Polar Scale*, and ſet it for the *Hour* f 7, in the line E A C. Then open the Compaſſes to 1 *Hour* 29 min. of the ſame *Scale*, and et it from A to 8. Then open your Compaſſes o 2 *Hours* 29 min. and ſet it from A to 9. Then pen your Compaſſes to 3 *Hours* 29 min. and ſet t from A to 10. Laſtly, open the Compaſſes to *Hours* 29 min. and ſet it from A to 11.

Now having found the points for the *Hours* on ne ſide of the *Subſtile* from A towards E, you muſt do the like for the other *Hours* on the other *ide* of the *Subſtile*: And conſidering that the firſt *Hour* from the *Subſtile* towards E, namely A 7, contains the diſtance of 00 *Hours* 29 min. as y the following *Table*; the *Complement* thereof o 60 min. or an *Hour*, is 00 *Hours* 31 min. as by he ſaid *Table* appears.

From A *towards* E.			From A *towards* C.		
H.	M.	h on the Plane	H.	M.	h. on the Plane
0	29	A 7	0	31	A 6
1	29	A 8	1	31	A 5
2	29	A 9	2	31	A 4
3	29	A 10	3	31	A 3
4	29	A 11	4	31	A 2

Proceed to ſet off 00 *Hours* 31 min. taken from the ſame *Polar Scale* from A to the *Hour* of 6, and extend your Compaſſes from the beginning of the *Scale* to 1 *Hour* 31 min. and ſet it from A to 5, alſo to 2 *Hours* 31 min. and ſet from A to 4, alſo to 3 *Hours* 31 min. and ſet it from A to 3; and Laſtly, the extent of the Compaſſes from the beginning of the *Scale* to 4 *Hours* 31 min. ſet off from A to 2, and ſo you have points for all the *Hours* on the *Plane* on the line C A H.

Now for the other line D B F, you muſt ſet off the *Hours* thereon (taken out of the *leſſer Polar Scale*) from B both ways according to the *Table*, in all reſpects as you did ſet off the *Hours* from A. This being done, draw lines through the reſpective Points found in the lines CA H, and D B F, and thoſe lines ſhall be the *Hour-lines* for this *Dial*.

The *Stile* muſt be a *thin Plate* of *Braſs* or *Iron*, and ſtand directly over the *Subſtile*, as in the *Figure* is demonſtrated, by A B and C D.

Thus have you finiſhed your *Dial*, and in the making of this you have made a *South Declining*

Weſt

eſt 80 deg. Alſo: for if you turn the Paper, nd look through it, it will on rhe back-ſide appear *Declining Weſt* 80 deg. only the Forenoon hours n this, muſt be the Afternoon *hours* in that: Nay, n rigour, you have in this one *Dial* made four, *North Declining*, either *Eaſt* or *Weſt*.

CHAP. VII. *Fig.* 18.

How to draw Hour-Lines *upon a* direct Eaſt-Dial, *Arithmetically*.

LET there be an *Eaſt Dial*, whoſe breadth is *6* Inches; and it is required to put on all he *Hour-Lines* from *6* in the *Morning* till 11 at *Noon*; here you 5 Hours and *6* Inches: Therefore, before you can work the *Operation*, you muſt turn the *Hours* into *Degrees*, by allowing for every *Hour* 15 *Degrees*, ſo you will have 75 *Degrees* for 5 *Hours*; then turn the Inches into Parts, by allowing 100 Parts to every Inch, ſo you will have 600 Parts.

I. For the height of the Stile.

As the Radius 90	10.00000
Is to the *Tangent* of 5 Hours 75 deg. com. A.	9.42805
So is the Log. of the diſtance from 6, 600 parts	2.77815
To the Log. of the *Stiles* height, in parts 161.	12.20620

That is, 1 Inch, 61 parts of an Inch, an Inch divided into 100 Parts.

As

II. For the Hour Lines diſtance from VI.

	As the *Radius* 90	10.000
	Is to the *Log.* of the *Stiles* height 161	2.206
7.	So is the *Tangent* of 15 deg. for 7 a Clock	9.428
	To the *Log* of the firſt Hour 43 parts,	11.634
	As the *Radius* 90.	10.00
	Is to the *Log.* of the *Stiles* height 161.	2.206
8.	So is the *Tangent* of 30 deg. for 8 a Clock,	9.761
	To the *Log.* of the 2d Hour 93 parts,	11.968
	As the *Radius* 90.	10.000
	Is to the *Log.* of the *Stiles* height 161	2.206
9.	So is the *Tangent* of 45 deg. for 9 a Clock,	10.000
	To the *Log.* of the 3d Hour, 161 parts.	12.206
	As to the *Radius* 90	10.000
	Is to the *Log.* of the *Stiles* height 161.	2.206
10.	So is the *Tang.* of 60 deg. for 10 a Clock	10.238
	To the *Log.* of the 4th Hour, 279 parts	12.445
	As the *Radius* 90	10.000
	Is to the *Log.* of the *Stiles* height 161	2.206
11.	So is the *Tang.* of 75 deg for 11 a Clock,	10.571
	To the *Log.* of the 5th Hour, 600 parts,	12.778

Having thus far proceeded, that 5 *Hours* fro 6 is calculated, namely, 7, 8, 9, 10, 11, there a yet 4 and 5 in the Morning that muſt be draw the ſame diſtance from 6 in the Morning, as 7 an 8 are; therefore, for your better Inſtruction, ſe the following Dial, and imitate this Geometrica Conſtruction.

Firſt, Square out your Dial, and draw the Lin D, A, C, towards the bottom of your Plain; the with 60 degrees of Chords in the Point C, on th edg dge of the Dial, deſcribe a part of a Circle as ,B, and ſet from A, to B, the complement of our Latitude 38°. 30' and draw the Line C, B, E, hro' the Plane for the Equinoctial.

Secondly, Have recourſe to your Table, and ake, in your Compaſſes, the diſtance in Parts etween 6 of the Clock and 11, namely 600, and nake Marks with both Feet in the Equinoctial or the *Hour-Lines* of 6 in the Morning, and 11, ut remember to leave room above 6, for 4 and in the Morning, then take in your Compaſſes 3 parts, and ſet from 6, to 7, and 5, then take in our Compaſſes 93 Parts, and ſet in the Equator or quinoctial, from 6 to 8 and 4; then take in your Compaſſes 161, and ſet in the Equinoctial from 6 to : Laſtly, take 279 parts, and ſet in the Equinoctial from 6 to 10, and thro' the Points in the quinoctial draw Perpendiculars, and they ſhall e the true *Hour-Lines*.

Note, The *Stile* muſt be the breadth of 6 and of the Clock, as you ſee in the Figure, and nuſt ſtand perpendicularly in the *Hour-Line* of 6 f the Clock.

IV.	093
V.	043
VI.	000
VII.	043
VIII.	093
IX.	161
X.	279
XI.	600

Note, If you have a mind to draw the Quarters and Half Hours, and Three Quarters, you may, if you obſerve what was ſaid in *Chap.* 2. *Page* 65.

SECT.

SECT. I.

Fig. 18.

How to draw the Hour-Lines, *upon a* Direct Eaſt *or* Weſt Dial *inſtrumentally by the* Polar Scale.

1. UPON the Point C, if it be an *Eaſt Dial*, or upon the point D, if a *Weſt*, with 60 deg. of your *Line* of *Chords*, draw an obſcure part of a Circle as A B, and in that Arch from A to B, ſet off the *height* of the *Equinoctial*, 38 deg 30 min. and draw the Line CDE, then in ſom convenient Place of the Line CE, as at R, draw the Line GRF, at right Angles to the Line EDC, ſo ſhall GRF, be the *Subſtile* and *Hour-line* of 6.

2. Draw IH, parallel to the Line EDC.

3. Repair to either of your *Scales* known by th letters [*Pol.*] and fix one Foot of your Compaſſe at the beginning of the ſaid *Scale*, and extend th other Foot to the *Hour* of 1. Set off that exten from G to 5, and from G to 7, and on its paralle EC, from R both ways, and draw the *Hours* of 5 and 7 paralle to the *Subſtile* and *Hour-line* of 6 Then take in your Compaſſes the diſtance from th beginning of the *Scale*, to 2 hours, and ſet it o from G to 4, and from G to 8, and alſo from R both ways, and draw the hour of 4 and 8 paralle to the other; ſo you have no more hours to ſet o towards I, being 4 is the hour of Sun-riſing; bu proceed to ſet off the reſt of the hours towards H as you did the other hours, taking in your Compaſſes the diſtances from the beginning of the *Scal* to 3, 4, and 5, and ſetting each diſtance off reſpectively from G towards H, at 9, 10 11, and

alſo

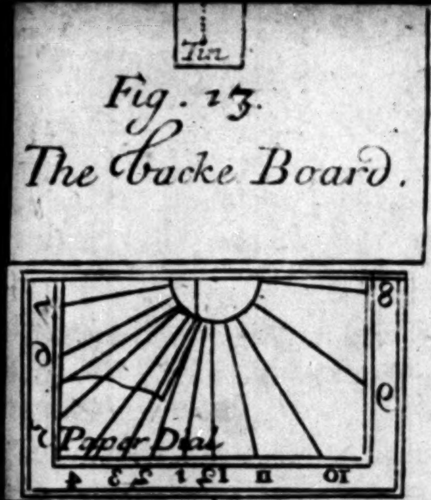


Fig. 13.
The backe Board.

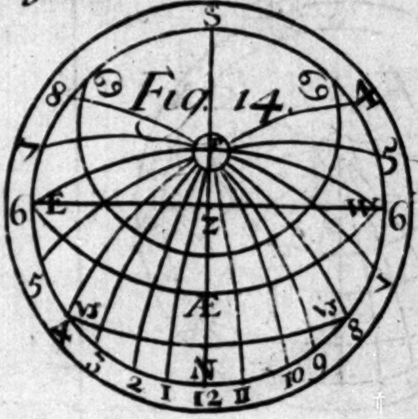
Fig. 14


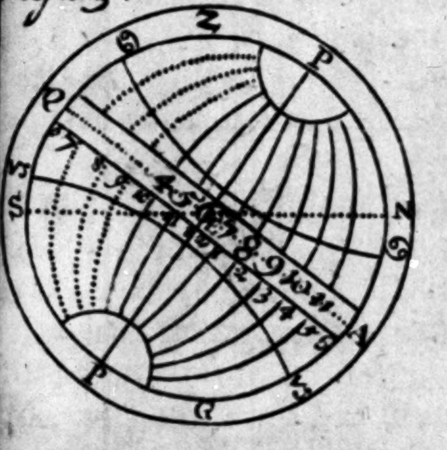
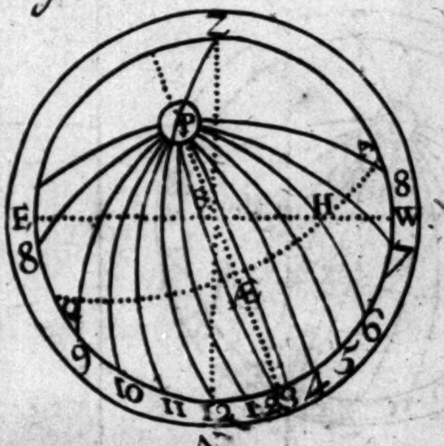
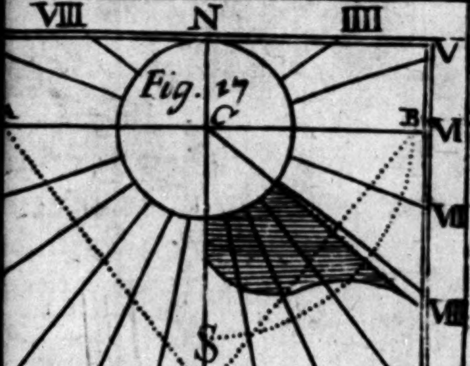
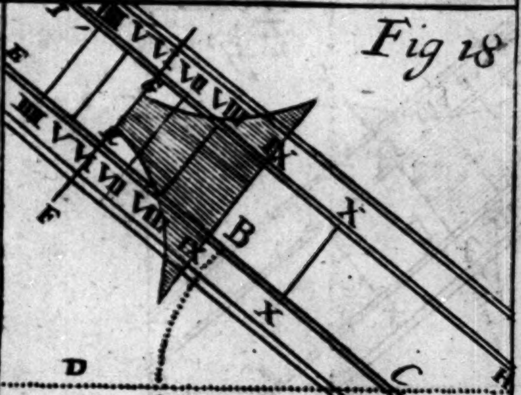
Fig. 15.


Fig. 16.






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lſo from R towards C, and draw the hours of , 10, and 11: and ſo you have all the hours proper for an *Eaſt Dial.*

4. And Laſtly, The diſtance from the beginning of he *Scale* to the hour of 3, gives the height of the *tile*, which muſt ſtand directly over the *Hour-line* f *6*, making Right-Angles therewith, and may be nade of a thin plate of Iron or Braſs, or a Pin harpned, whoſe extremity muſt give the ſhadow o the *Hour-lines* on the *Dial.*

Note, That if you turn the *Eaſt Dial* drawn on aper from you, and look on the back-ſide, you hall ſee the perfect Form of a *Weſt Dial*, only nſtead of the Hours 11, 10, 9, 8, 7, 6, 5, 4, ou muſt write 1, 2, 3, 4, 5, 6, 7, and 8.

CHAP. VIII.

How to find the Reclination *of any* Plane.

TAke a *Quadrant* and joyn it to the *Side* of a *Square*, and place the other *Side* of your *quare* to the *Plane*; if the *Plummet* fall Parallel o the *Side* of the *Square*, then the *Lower-ſide* of he *Square* ſtands *Level*, by which draw an *Horizontal-Line*, on which erect a *Perpendicular*, nd pply your *Square* to that *Perpendicular*, and if he *Plummet* falls Parallel to the *Side* of the *quare*, then that is alſo a *Level* Line, and your *lane* ſtands *Horizontally*: If the *Plummet* falls ot Parallel to the *Side* of the *Square*, then turn our *Square* until it does, then draw an *Horizontal-Line*, on which erect a Perpendicular to which apply your *Square*, and obſerve what *Angle* your Plummet makes on the *Quadrant*, with the *Side* of the *Square*, that is the *Angle* of the *Reclination* of the *Plane*.

CHAP. IX. *Fig.* 19.

Of direct Eaſt *or* Weſt Reclining Dials, *and how* Hour-lines *may be deſcribed upon them.*

AS all Direct *North* and *South Reclining Dials* are reduced to *New-Latitudes*, wherein they would be *Horizontal Dials*; ſo all Direct *Eaſt* or *Weſt Reclining Dials*, in any one *Latitude*, may be reduced to Upright Declining Dials in another *Latitude*.

Definition.] An *Eaſt* or *Weſt Reclining Dial*, is a Dial that directly beholds the *Eaſt* or *Weſt*, and Recline or fall back like the *Roof* of an *Houſe*.

SECT. I.

To reduce any Eaſt *or* Weſt Reclining Dial, *in any* Latitude, *to a* New-Latitude, *wherein the* Reclining Dial *ſhall become an* Upright Dial, *and what* Declination *that* Upright Dial *ſhall have in that* New-Latitude.

Example.

Suppoſe then, that a *direct Eaſt*, or *Weſt Dial* in the *Latitude* of *London* 51:30, ſhould *Recline* from the *Zenith* 35 deg. in what *Latitude* will that be an *Upright Dial*? And what *Declination* ſhall it have in that *Latitude*?

RULE.

The *Complement* of the known *Latitude*, is (always) the *New-Latitude*; and the *Complement* of the *Reclination* is (always) the *Declination* in that *New-Latitude.*

So that if an *Eaſt* or *Weſt Dial* ſhould *Recline* 35 deg. in the *Latitude* of 51:30. that will be an *Upright Dial*, declining 55 deg. in the *Latitude* of 38:30.

For 38:30. being the *Complement* of 51:30. is the *New-Latitude*. And 55 deg. being the *Complement* of 38:30 deg. the *Dials Reclination* is the *Declination* in that *New-Declination.*

The Canon for Calculation are,

I.

As the Radius ——— ——— ——— 90:00 — 10.00000
Is to the Sign of the *Declinat.* 55:00 — 9.91336
So is the Co-Tangent of the *Lat.* 38:30 — 10.09939

To the Tan. of the Sub. diſt. 45:52 — 10.01275

II.

As the Radius ——— ——— — 90:00 — 10.00000
Is to the Co.Sign of the *Decli.* 55:00 — 9.75859
So is the Co-ſign of the *Latitude.* 38:30 — 9.89344

To the ſign of theStiles height, 26:41 — 19.65213

III.

As the Radius, ———————— 90:00—10.00000
Is to the Co-Tang. of the *Decli.* 55:00— 9.84522
So is the Sign of the *Latitude.* 38:30— 9.79415
————
To the Co-Tang. of the *Planes Long.* } 66:27—19.63937
————

Weſt	*Eaſt*	*Equinoctial Diſtances.*		*True Hours on the Plane.*	
H.	M.	D.	M.	D.	M.
10	02	83	33	75	50
09	03	68	33	48	49
08	04	53	33	31	18
07	05	38	33	19	41
06	06	23	33	11	04
05	07	08	33	03	52
Subſtile.					
04	08	06	27	02	54
03	09	21	27	10	00
02	10	36	27	18	21
01	11	51	27	29	24
12	12	66	27	45	52
11	01	81	27	71	29

H:

Having *Calculated* the *Requiſites*, and made the *Table* after the manner of a *declining-Dial*; and and the *Hour Arches* calculated, we proceed to the *Geometrical Projection* of a Weſt Recliner.

Draw the *Line* A, D, for the Horizontal Line of your reclining Plane; then at a convenient diſtance, and Parallel to the Line A, D, draw the Line G, O, 12, for the 12 of the Clock *Hour Line*, and making G, the Centre of your Dial, with 60 deg. of *Chords*, in G, deſcribe the Circle O, R, p, d, and from O, to R, ſet the Subſtiles diſtance from the *Meridian* 45. 52 min. and from R. to p. ſet 26. 41 the Stiles height, and draw R, G, for the Subſtile, and p. G, for the Stile; then take out of your Table 03:52, 11:04, 19:41, 31:18, 48:49, 75:50, and ſet from R, the Subſtile, for the *Hours* of 5, 6, 7, 8, 9, and 10; likewiſe take 02:54, 10:00, 18:21, 29:24, 45:52, 71:29, and ſet for the *Hours* of 4, 3, 2, 1, 12, 11, and thus you have all the *Hours* as you ſee in *Fig.* 19.

SECT. II.

How to draw this Dial *by the* Line *of* Latitude *and* Scale *of* Inclination *of the* Meridian.

HAving found the Equinoctial Diſtance as before, and drawn the Horizontal Line, the *Hour Line* of 12, and ſet off the Subſtiles diſtance and Stiles height, proceed after this manner: Draw a Line perpendicular to the Subſtile, paſſing thro' the Centre, as a G, and take off your Line of *Latitude* 26 deg. 41 min. and ſet from G to *a*, and B; then take the length of the whole Scale of the Inclination of the *Meridian* in your Compaſſes, and ſet one Foot in *a*, and turn the other abovt till it touch, or croſs the Subſtile as at *b*, and draw the Line *b*, *a*, and *b*, *b*, then repair to your Table of Equinoctial Diſtances and take off your Scale of Inclination of *Meridian* 06:27, 21:27, 36:27, 51:27, 66:27, 81:27, and ſet one after another on the Line *b*, *a*, from *b*, towards *a*, for the *Hours* of 4, 3, 2, 1, 12, and 11 of the Clock; then take 08:33, 23:33, 38:33, 53:33, 68:33, 83:33, and place from *b*, towards *b*, for the *Hours* of 5, 6, 7, 8, and 9, of the Clock.

Note, That 9 of the Clock is to be drawn thro' the *Centre* for the *Hour* of 10 in the *Morning*, becauſe the Sun ſhineth not in our *Latitude* but 13 min. *after* 8 at Night.

And thus you have at one Work made 4 Dials, *viz*. a *Weſt Recliner* and an *Eaſt Recliner*, and a *Weſt Incliner* and an *Eaſt Incliner*, for if you turn the Dial the bottom upwards, the *Centre* will be *Northwards*, and the *Axis* point *Southwards*, and thoſe *Hours*, viz. 3, 4, 5, 6, 7, and 8, will be the *Afternoon-hours* of a *Weſt* Inclining Dial; and if you obſerve the ſame of the *Eaſt* Reclining Dial, it will produce the *Eaſt* Inclining Dial.

Note, In the making of the *Eaſt* Reclining Dial, your *Centre* muſt be on the Left-hand ſide of the Plane, and the *Hours* run the other way, as you may ſee if you turn your Dial, and look thro' the back-ſide of it.

SECT.

SECT. II.

The Height *of the* Stile, *the* Declination *of the* Sun, *and the* Reclination *of the* Plane *given, to find what time the* Sun *forſaketh the* Eaſt *or* Weſt Reclining Dial, *and ſhineth on the oppoſite* Incliner.

Definition. THE Planes of *Eaſt* and *Weſt* Recliners or Incliners lie in the Circle of Poſition, denominating their Reclination; and to find the time the *Sun* forſaketh the one to ſhine upon the other, obſerve this general *Canon.*

As the *Radius*	90.	10.00000
Is to the *Tang.* of the *Sun*'s decl.	23.30.	9.63830
So is the *Tang.* of the Stiles height	26.41.	9.70120
To the *Co-Sine* of	77:22	19.33950
To which add the Planes *Long.*	66:27	
And the Sum is	143:49	
Whoſe Complement to 180 is	36:11	

Which 36.11 reſolveth into Time, by allowing 15 deg. to an *Hour*, and to every odd deg. 4 min. giveth 2 hours 24 min. after Noon when the Sun (in *Cancer*) forſaketh the *Eaſt* Reclining Dial 35, and illuminateth the Oppoſite, the *Weſt* Inclining Dial, or it giveth 2 hours 24 min. beſore Noon, when the Sun parteth from the *Eaſt* Reclining Dial, and ſhineth upon the *Weſt* Inclining Dial.

Note, That upon all *Eaſt* and *Weſt* Recliners in the *Northern Hemiſphere*, the *North Pole* is elevated; and on their oppoſite Incliners the *South Pole*.

Note, The *Meridian* upon all *Eaſt* and *Weſt* Reclining Dials, lies parallel to the Horizon.

CHAP. X.

How to draw the Hour-Lines, *upon Direct* South *or* North *Reclining Dials.*

SUCH *Planes* as do directly behold the { *North* / *South* } Point of the *Herizon*, but do *Reclining* (or fall backward) from the *Zenith* towards the { *South* / *North* } are called { *North* / *South* } *Direct Planes Reelining*: So many Degrees as the *Reclination* is: And of ſuch *Planes* their are Six *Varieties*; Three of *South*, and Three of *North Recliners*: All which may be *Reduced* to *New Latitudes*, wherein they will become *Horizontal Planes*: And conſequently *Dials* (or *Hour-lines*) may be deſcribed upon them by the *Precepts* delivered in the I Chapter page 15.

1. *Of* South Recliners.

Examples of all theſe *Varieties* of *Reclining Planes*, in the *Latitude* of *London* 51 deg. 30 min. To find the *New Latitude*.

1. Variety. Let there be a *Direct South Plane*

in

the *Latitude* of *London*, which *Reclines* from e *Zenith* thereof 20 deg. In what *Latitude* ill that be an *Horizontal* Plane ? The Planes eclination 20 deg. being leſs then 38 deg. min. the Complement of the *Latitude* of *ondon* , Subſtract 20 deg. from 38 deg. 30 min. e *Remainder* (or *differance* (18 deg. 30 min. is e *New-Longitude*. So that an *Horizontal Dial* ade for that *Latitude* ſhall be a *South Reclining* deg. in the *Latitude* of *London*.

2. Variety. If a *South Plain* in the *Latitude* f 51 deg. 30 min. ſhould *Recline* 60 deg. from e *Zenith* thereof: In what *Latitude* will that e an H*orizontal Plane ?*

The *Reclination* of the *Plane* 60 deg. being eater then 38 deg. 30 min. the *Complement* of e *Latitude* of *London*, Subſtract 38 deg. 30 min. om 60 deg. and the *Remainder* 21 deg. 30 min. the *New Latitude* : And and *Horizontal Dial* ade for that *Latitude* of 21 deg. 30 min. ſhall rve for a *South Dial Reclining* 60 deg. in the *atitude* of *London*.

3. Variety. If a *South Plane* in the *Latitude* f *London* ſhould Recline from the *Zenith* thereof 38 deg. 30 min. *Equal* to the *Complement* of the *atitude* of *London*. Then,

The difference between the *Complement* of the *atitude* of *London* and the *Reclination* being nothing; it ſhews the *New-Latitude* to be no *Latitude*, that is neither *Pole* hath any *Elevation* over ſuch a Plane, but is an *Equinoctial Plane*, and muſt be made by the Rules delivered in the 6 Chapter of this Book, or by page 61.

2. *Of*

2. *Of* North Recliners.

1. **Variety.** If a *North* Plane in the *Latitu* of 51 deg. 30 min. ſhould *Recline* from the *Z* *nith* 20 deg. In what *Latitude* will that be *Horizontal* Plane ?

The *Reclination* 20 deg. being leſs then t *Complement* of the *Latitude* of *London*, 38 d 30 min. add the *Reclination* 20 deg. and the *Latitude* 38 deg. 30 min. together; their ſu 58 deg. 30 min. is the *New Latitude*: And *Horizontal Dial* for that ſhall be a *North* Pla *Reclining* 20 deg. in the *Latitude* of 51 d 30 min.

2. Variety. If a *North Plane* in the *Latitu* of *London*, 51 deg. 30 min. ſhould *Recline* fro the *Zenith* 75 deg. In what *Latitude* will ſu a Plain be *Horizontal*?

The *Reclination* 75 deg. being greater th 38 deg. 30 min. Add them together and th make 113 deg. 30 min. which being above 90 de take the *Complement* thereof to 180 deg. whi is 66 deg. 30 min. And that is the *New-Latitud* So that an *Horizontal Dial* made for the *Latitu* of 66 deg. 30 min. will be a *North* Plane *Recli* *ing* 75 deg. in the *Latitude* of *London* 51 de 30 min.

3. Variety. If a *North* Plain in the *Latitu* of *London* 51 deg. 30 min. ſhould *Recline* fro the *Zenith* thereof 51 deg. 30 min. In wha *Latitude* will ſuch a Plain be *Horizontal*?

Here the Reclination 51 deg. 30 min. is Equa to the Latitude of *London*; and the Sum of th

Re

eclination 51 deg. 30 min. and the Complement f the *Latitude* 38 deg. 30 min. Added together, eir Sum is 90 deg. for the *New Latitude* : And Horizontal Dial made for that Latitude of deg. will be a *North* Plane Reclining 51 deg. min. in the Latitude of *London*, and muſt be ade by the Rules delivered in the 30*th* Chapter this Book.

Note, that upon all *South* Reclining Direct *ials*, if the Reclination be leſs than the Comple- ent of the *Latitude*, the *South* Pole is Elevated; equal to the Complement of the Latitude, nei- er Pole is Elevated, but is an *Equinoctial*, and made by Chap. VI. And if more than the Com- ement of the *Latitude*, the *North* Pole is Ele- ted, and the Center of the *Dial* is at the bottom. d upon the *North* Inclining leſs than an Equi- ctial, the *North* Pole, equal to an Equinoctial, ither Pole, and more than a Equinoctial the *uth* Pole.

Note, 2. That upon all *North* Direct Reclining *ials*, the *North* Pole; And on all Direct Inclin- g *Dials*, the *South* Pole.

SECT. I.

he height of the Stile, *the Declination of the* Sun, *and the Reclination of the* Plane *given, to find what time the* Sun *ſhall forſake a* North *Inclining* Plane, *to ſhine upon a* South *Reclining* Plane, *oppoſite thereto.*

THere is ſix Varieties of *North* and *South* Reclining and Inclining *Dials* --- And firſt of

the three *South*, I. In that which Reclines 20 d
being leſs than an Equinoctial, their are giv
the height of the Stile 18 deg. 30 min. the Dec
nation of the *Sun* 23 : 30. to find at what ti
the *Sun* forſaketh the *North* Inclining Plane,
Shine upon the aforeſaid *South* Reclining 20 deg

As the Radius, ——	90 : 00.	10.000
Is to the *Tan.* of the *Sun's Decl.*	23 : 30.	9.638
So is the *Tan.* of the *Stiles* heig.	18 : 30.	9.524
To this Co-ſine, ——	81 : 38.	19.162

Subtract this 81 : 38. out of 90 deg. there wi
remain 8 deg. 22 min. which converted into tim
giveth 34 min. before 6 in the Morning, and aft
it at Night, when the *Sun* in Cancer departe
from the Inclining ſide of the Plane, and Shine
on the Reclining and contrary.

2. Of that which Reclines to the Pole, or equ
to the Complement of the *Latitude*; This *Di*
lyeth in the Six a Clock *Hour-Circle*, and ther
fore the Caſe is plain, that the *Sun* always paſſe
from one ſide of the Flat to the other juſt at Six o
the Clock; and from the 13*th* of *September*, t
the 10*th* of *March* (or the *Sun's* abode in th
Southern Signes) the *Sun* ſhines not at all up
the reclining ſide.

3. In that which Reclines 60 deg. being mor
than an Equinoctial; there are given the *Stile*
height 21 : 30. the *Sun's* Declination 23 : 30, t
find at what time the *Sun* parteth with the *North*
In

lining *Dial*, to ſhine on the *South Reclining* poſite thereto.

the Radius,	90.00.	10.00000
to the *Tang.* of the *Sun's Decl.*	23.30.	9. 63830
is the *Tang.* of the Stiles heig.	21.30.	9. 59539
this Co-ſine	80.08.	19.23369

Subtract this 80 : 08. out of 90. and their will main 09. 52. which converted into time giveth hours 39 min. before Six a Clock in the orning, and after Six at Night, when the *Sun* *Cancer* departs from the Inclining ſide to illuinate the oppoſite Recliner, and contrary. And us may you be ſatisfied for any other Declination of the *Sun* whatſoever.

SECT. II.

he height of the Stile, *the* Declination *of the* Sun, *and Reclination of the* Plane *being given, to find what time the* Sun *forſaketh the* North *Reclining* Dial, *to Shine upon the* South *Inclining* Dial.

IN *North* Direct *Recliners*, their are three Varieties which ſhall be ſpoke of as followth.

1. Of the *North* Reclining 20 deg. This Dial uring the *Suns* Southern Declination, it only ines upon the Inclining ſide: but during his bode in the *Northern* Sines, ſome part of the

Day on the Reclining ſide, and ſome part on t Inclining ſide; whoſe quantity of time is fou by the following Proportion.

As the *Radius* —— —— 90.00. 10.000
Is to the *Tang.* of the *Sun*'s decl. 23.30. 9.638
So is the *Tang.* of the Stile height, 58.30. 10.212

To this Co-ſine of —— —— 44.48. 19.950

Which 44.48, reſolved into time, giveth hours 59 min. before, and after Noon, when t *Sun* in *Cancer* forſaketh, and returneth again t the reclining part of the *Plane.*

2. Of the North Reclining 51.30. being a P *lar Dial:* This Dial lying in the Equinocti Circle, hath the Sum during his abode in t *Northern Sines*, ſhining only on the reclining Side and the Sun in the *Southern Sines* ſhines upon th Inclining Dial.

3. Of the North Reclining 75 deg. being mo than a *Polar*: This Dial, during the Sun's abod in the Northern Sines, hath the Sun only ſhinin on the Reclining Dial; the reſt of the Year i ſhineth upon both (whoſe time is eaſily found b the Declination) until the *Meridional* receſs o the *Sun* from the *Zenith* (or the *Zenith* diſtanc which is all one) be greater than the *Reclinatio* of the *Plane*, and then it ſhineth only upon th *Inclining Plane.*

To find the time of the Year for that, Subtra the *Reclination* of the Equinoctial 51.30. fro the *Reclination* of the *Plane* 75, and there wi

remai

ain 23.30. the Declination of the Paralſel in ich the *Plane* lieth, which is the firſt degree *Capricorn*, (as you will find by Calculation) at that time which is the 10*th* of *December*, Sun forſaketh the Reclining *Plane* to ſhine y on the Inclining Dial, as yon will find by following Proportion.

the Sine of the *Sun's* Decl. 23.30. 9. 60069

to the Radius——— ——— ———90.00. 10.00000
is the Sine of the Difference 23.30. 9. 60069

this Sine——— ——— ——— ———90.00. 10.00000

Which is the third Sign from *Libre*, namely *pricorn*, (as I ſaid before) when it forſaketh reclining *Dial*, to ſhine only upon the Inclin- *Dial*, and ſo continues till it aſcends again to *ncer*, which is the Paralelliſme with it, which the 10*th* of *June*.

I have choſe this *Dial*, reclining 75 deg. be- uſe the Operation, or Working, may ſeem dif- ult, becauſe the firſt term 23.30, which muſt ways be ſubtracted from the third, (which is . 30,) the remainder is 90. 00.

I ſhall here give you the Working of the Canon a *Dial* reclining but 70 deg.

Example.

the ſine of the *Sun*'s Decl. 23.30. 9. 60069

to the Radius——— ——— ———90.00. 10.00000
is the ſine of the Difference, 18.28. 9. 50072

this ſine——— ——— ——— ———52.33. 9. 89973

Out of 52 : 33, ſubtract 30 deg. for the ſine *Libra* there will remain 22. 33, of *Scorpio* for the plac of the *Sun*, when it forſaketh the reclining *Dial* to ſhine only on the Inclining *Dial*, till it aſcend again into 07 : 27, of *Aquaries*, which is in Parallelliſme with it, by this place of the *Sun* every Almanack will ſhew the time of the Year.

Note alſo, That in making of any of theſe *North* or *South* reclining *Dials*, you have made alſo a Direct North or South Dial inclining from the *Zenith* towards the Horizon, ſo many Degrees

as the { Recli- / Incli- } nation.

So that when you have made a South Dial reclining from the *Zenith* 60 deg. (as II the ſecond Variety of *South* recliners in this Chapter) you have alſo a *North* Dial *Inclining* to the *Horizon* 60 deg. either by drawing the Hour-lines and *Stile* through the *Center*, or by turning the Reclining Dial about upon the Hour-line of VI. And then as the *North* Pole is Elevated upon the *South* recliner ; ſo much will the *South* Pole be Elevated above the *North* Incliner, &c.

Of

Of *Declining* and *Reclining* *Planes*,

CHAP. XI.

As there were ſix Varieties of Direct *North* and *South* reclining Planes, ſo alſo are their of *South* and *North* Declining reclining Planes, *viz.* Three Varieties of *South* recliners declining, and as many of *North* recliners declining.

Of South *Recliners Declining* Planes.

I. The declination may be ſuch, that the reclining Plane, ſhall interſect the *Meridian* between the *Zenith* of the place and the Pole of the World.

II. The Declination may be ſuch, that the *South* reclinining Plane, may fall upon the *Meridian* juſt upon the Pole-point; and ſuch Reclining Declining Planes, are called Equinoctial Decliners.

III. The Declination may be ſuch, that the *South* Decliner may fall between the Pole of the World, and the Horizon.

Theſe are the three Varieties of *South* recliners Declining.

In *North* Decliners reclining, there are three other Varieties.

1. The Declination may be ſuch, that the reclining Plane, may cut the *Meridian*, between

the *Zenith* and the Equinoctial.

II. The Declination may be ſuch, that th *North* reclining declining Plane, may croſs th *Meridian* in the Point where the Equinoctial cu it.— And ſuch Planes are called Polar declinin Planes, becauſe the Poles of them lie in the Axi of the World, and the Subſtile in ſuch Planes, wil be always Perpendicular to the *Meridian* of th Place.

III. The Declination may cauſe the reclinin Plane to cut the *Meridian*, between the Equi noctial and the Horizon.

Examples of all theſe Varieties follow.

I. *Of South Recliners,*

The *Firſt Variety.*

CHAP. XII.

Fig. 24

To draw Hour-lines, *upon a* South *Reclining Plan* *Declining* Eaſt *or* Weſt, *which paſſeth betwee* *the* Zenith *and the* Pole.

Example.

LET the Lat. of the place be *North*, 51 : 3
The decl. of the Plane be *Eaſt*, 20 : 0
The reclination of the Plane be 20 : 0

I. To find the New-Latitude, wherein thi Plane ſtands as an upright Decliner.

The

The Canon for Calculation,

As the Radius	90.00.	10.00000
Is to the Co-ſine of the Old decl.	20.00.	9. 97298
So is the *Co-Tang*. of the recl.	20.00.	10.43893
To the Tangent of	68.49.	10.41191
The *Lat*. of the place Subſtracted	51.30.	
There remains	17.19	

Whoſe Complement 72.41, is the *New-Latitude*.

II. The referring of this Plane to a new-Latitude, doth alter the *Declination* alſo; therefore a New-Declination muſt be found.

The Canon for Calculation,

As the Radius	90.00.	10.00000
Is to the Co-ſine of the *Recl.*	20.00.	9. 97298
So is the ſine of the *Old-Decl.*	20.00.	9. 53405
To the ſine of the *New-decl.*	18.45.	19.50703

Having found the New Latitude and Declination, you may find the *Subſtiles* diſtance, the Stiles height, and the *Planes* difference of Longitude, by the Chapter, which are as followeth.

The height of the Pole above the *Horiz.*	51.30.
The Planes Old Declination,	20. 00
The Reclination	20. 00
The *Planes* New Latitude	72. 41
The Planes New Declination	18. 45
The *Subſtiles* diſtance from the *Meridian*,	05. 43
The Stiles hight.	16. 23
The *Planes* difference of Longitude,	19.34.

The

Having found the Longitude and reſt of the things neceſſary, you may frame a Table of Angles at the Pole, as was directed in the Chapter, in upright decliners; and from thence you may find alſo the Hour *Arches*, and ſet them down in a Table as you ſee here followeth.

	Angles at the Pole		Hour Arches		
H. Eaſt.	*d.*	*m.*	*d.*	*m.*	*H. Eaſt.*
5	85	26	74	11	7
6	70	26	38	26	6
7	55	26	22	16	5
8	40	26	13	31	4
9	25	26	07	38	3
10	10	26	02	58	2
Subſtile.					*Subſtile.*
11	04	34	01	17	1
12	19	34	05	44	12
1	34	34	11	00	11
2	49	34	19	07	10
3	64	34	31	40	9
4	79	34	56	53	8

But to draw this *Dial* upon the *Plane* in the Old Latitude, your are not to place the *Hour-line* of 12 *perpendicular* to the *Horizon*, as in upright *planes* but it muſt make an *angle* with the *Horizontal* line of the reclining *plane*: And therefore the quantity of that *Angle* muſt be found therefore, The Canon for Calculation is,

As the Radius.	—— —	90.00.	1000000
Is to the ſine of the Reclination.		20.00.	953405
So is the *Tang.* of the Old decl.		20.00.	956106
To the *Co-Tan.* of the diſ. of the *M.* & *H.*		82.54.	909511

Having found the Quantity, the *Meridian* makes with the Horizontal-line; the next thing is to find to what Coaſt it muſt run, and either above it or below it.

Now in all *South* Planes that doth recline and decline ſo much that the *Plane* becomes leſs than an *Equinoctial* Plane, the *Meridian* doth defend below the Horizontal line at that end which lies contrary to the Coaſt of the Declination. And in all *North* Planes Inclining and Declining, ſo much as to make it leſs than an *Equinoctial* Plane, the *Meridian* will aſcend above the *Horizontal* line at that end which lies contrary to the *Coaſt* of the Planes *Declination*.

Having ſhewed you to what Coaſt the *Meridian* muſt run; we now come to the drawing of the *Dial*, Geometrically.

The Geometrical Projection,

Draw the line W C E, for the *Horizontal* line of the *Plane*, then in the point C, with 60. deg. of Chords deſcribe the Circle W M E, and from W, to M, (becauſe the Plane *Declines Eaſt*) ſet 82. 54, the diſtance of the *Meridian* and *Horizon*, and draw the line C M, for the Hour-line of 12.

Then take 05. 43. the *Subſtiles* diſtance, and ſet from M, to O, and 16. 23, and ſet from O to P, and draw C O, for the *Subſtile*, and C P, for the *Stile*.

Laſtly, Take 01. 17, 05. 44, 11. 00, 19. 07, 30. 40, and 56. 53, and ſet from O towards E, Likewiſe take 02. 58, 07. 38, 13. 31, 22. 16, 38. 26, and 74. 11, and ſet from O, towards W, and from C, the Center draw lines to every one of the Points, they will be belonging to the *Plane*.

How to draw this Dial by the Line of Latitudes, and Hour Scale; the Requiſites being Calculated.

Having drawn your Horizontal, and ſet off the diſtance of the *Meridian* from the *Horizon*, the Subſtiles diſtance from the Hour line of 12 or *Meridian*, and the Stiles height, draw a Line as B D, paſſing thro' the Center C, and *Perpendicular* to the *Subſtile*.

Then out of your Scale of *Latitudes*, in page 62 take 16, 23, and ſet from C to B, and D, then take in your Compaſſes, the length of the whole Scale of 6 *Hours*, and ſet one foot in B, and turn the other foot till it touch the *Subſtile*, as at A, and draw the line A B, and A D.

The Inclination of *Meridians* in this Example, was found to be 19. 34, ſeek that on the ſecond Scale of 90 deg. and juſt againſt it on the firſt Scale you ſhall find 1 hour 19 min. which ſhews that the *Subſtile* ſtands upon 19 min. paſt 1, on the *Dial* declining *Weſt*, and 41 min. paſt 10 on the *Dial* declining *Eaſt*.

Now repair to your Table of *Angles* at the *Pole*, and take 04. 34, from your Scale of Inclination of *Meridians*, *Mer.* and ſet from A, to *XI*, and from B, to V, then ake 19. 34, and ſet from A, to XII, and from B, o VI. then take 34. 34. and ſet from A to 1, and from B, to VII. then take 49 34 and ſet from *A*, o II, and from B, to VIII. then take 64. 34. and ſet from *A*, to *III.* and from B, to IX. then take 79. 34. and ſet from A, to IV, and from B, to *X*. *Laſtly*, Lines drawn from the Center C, thro' every one of theſe points ſhall be the *Hour-lines* for ſuch a *Dial.*

Eaſt.	*A. P.*	*Weſt.*
11.	04.34	1.
12.	19.34	12.
1.	34.34	11.
2.	49 34	10.
3.	64.34	9.
4.	79.34	8.

How to find what time the Sun forſaketh the North Inclining Plane to ſhine upon this South reclining Plane.— The Sun being in Cancer.

As the Radius 90 00. 10.00000
Is to the *Co-Tan.* of the *Suns Decl.* 66. 30. 9. 68865
So is the *Tang.* of the Stiles height. 15.45. 9. 45029
To the Co-ſine, of —— —— 82.57 9. 08894
From which Subt. *Planes Long.* 19.34
There will remain ——— 63.23

which converted into time, by allowing 15 deg. for every Hour, and a deg. to 4 min. gives 4 *Hours* 13 min. after Noon, when the *Sun* parteth from the *Plane*, declining and reclining 20 deg. 00 min. *Eaſtwards* and ſhineth upon the *North* Inclining *Weſt*, the part oppoſite thereto: To find the time in th Morning, when the *Sun* forſaketh the *North* Inclining *Weſt*, to ſhine upon the *South* declinin *Eaſt*.

Unto the Co-ſine before found *viz.* 82.57
Add the planes Longitude, — ——— 19.34
The *Sum* is, ——— ——— ——— 101 : *91*

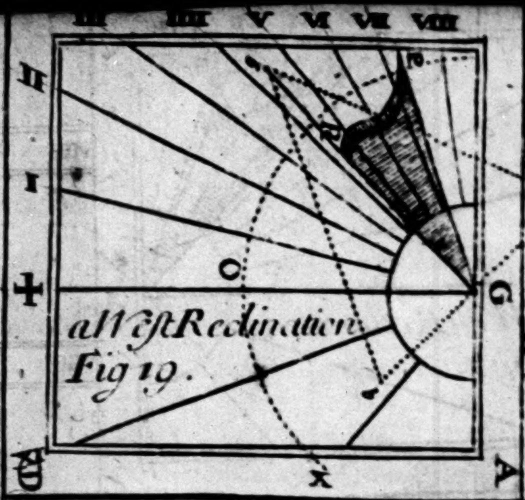
Which is 202. 31, that be reſolved into time giveth *6* hours 50 min. from Noon, that the *Sun* leaveth the *North* Inclining Plane, to ſhine on the *South* Recliner: Or if you take the Complement of 102. 31, to 180 deg. which is 77. *29*, it giveth 5 hours 10 min. the time from Noon.

CHAP. XIII.

HAving the Declination given, to know what Reclination will make it an *Equinoctial* Dial, Or having the Reclination given, to know what Declination it requires to make it alſo an *Equinoctial* declining *Dial*.

Whereby you may know at any time if your reclination and declination: or declination and reclination makes your Dial plane more, or leſs, than an *Equinoctial* declining Dial.

Let


III
IIII
V
VI
VII
VIII
II
I
+
XI
O
G
X
A
a West Reclination
Fig 19.

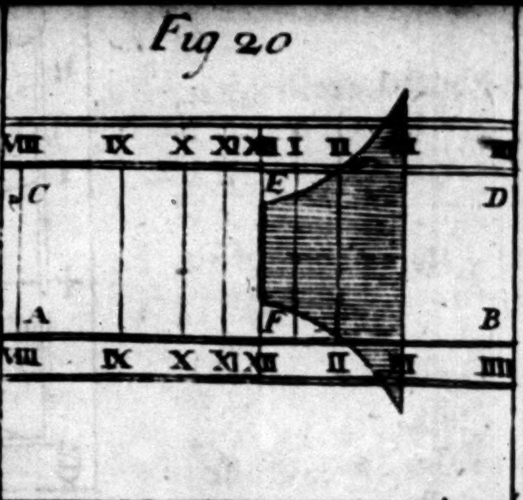


Fig 20
VIII
IX
X
XI
XII
I
II
III
IIII
C
D
E
A
F
B

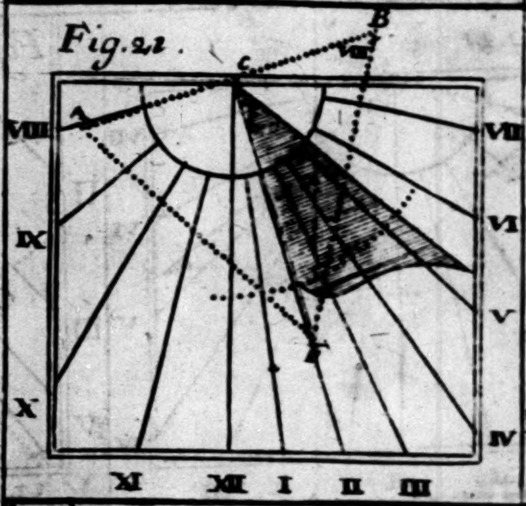


Fig. 21.
B
c
a
VIII
VII
IX
VI
V
X
IIII
E
XI
XII
I
II
III

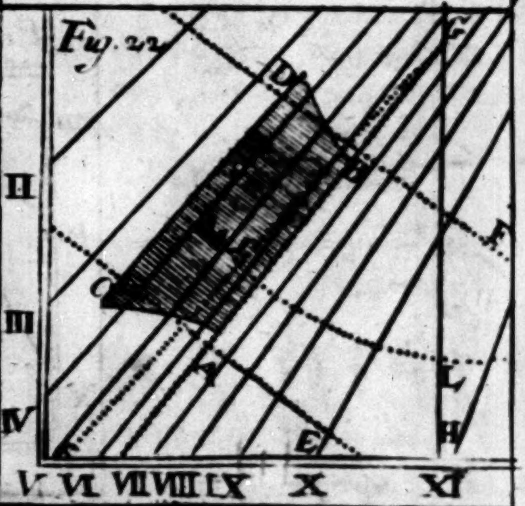


Fig. 22
G
D
II
F
C
III
A
L
IIII
E
H
V
VI
VII
VIII
IX
X
XI

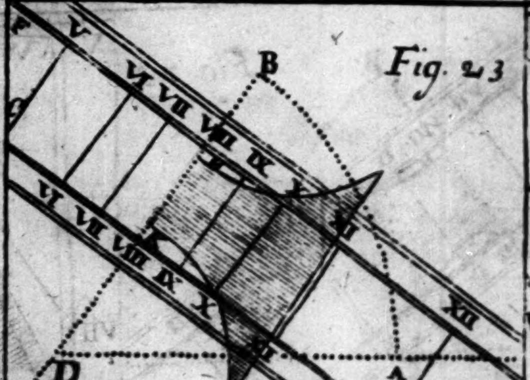


Fig. 23
F
V
VI
VII
VIII
IX
X
XI
B
VI
VII
VIII
IX
X
XI
XII
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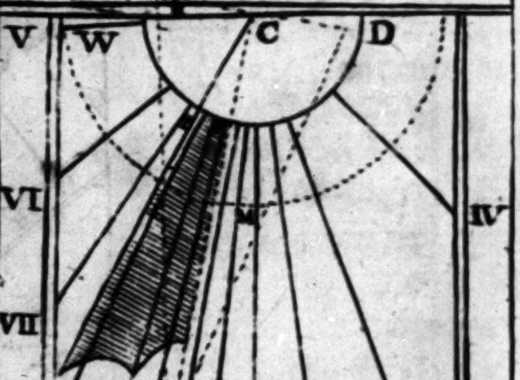
A
G
XII
E


V
W
C
D
VI
IIII
M
VII
VIII
IX
X
XI
XII
I
II
III

Let the declination given be 65 deg. 40 min.

As the Radius 90.00 ——— ———		10.00000
Is to the Co-Tang. of the *Ltait.*	51.30.	9.90060
So is the Co-ſine of the Declina.	65.40	9.61494
To the *Tang*. of the Reclina.	18.09	19.51554

Let the Reclination given be as found 18.09

As the *Radius* 90.00 ——— ———		10.00000
Is to the *Tang*, of the Latitude	51. 30	10.39939
So is the *Tang*. of the reclina.	18 09	9.51563
To the Co ſine of the declina.	65.40.	19.61502

C H A P. XIV. *Fig.* 23.

How to draw the Hour-lines *upon any* Declining *Equinoctial Plane.*

Let the Example be of a South *Plane*, *Declining Eaſt* 65 deg. 40 min. and *Reclining* 18 deg. 9 min. in the *Latitude* of *London* 51 deg. 30 min.

IN *Declining Reclining Equinoctial Dials*, before the *Hour-lines* can be drawn, three things muſt be given, and two things found; the things iven are,

1. The Latitude of the place,	51	30
2. The Declination of the Plane,	65	40
3. The Planes Reclination,	18	9

The things found are,

1. The diſtance of the *Meridian* and *Horizon*.
2. The Inclination of the *Meridians*.

For the diſtance of the *Horizon* and the *Meridian*, Thus,

As the Radius, or ſine of 90 deg. 10.000000
Is to the ſine of the reclination, 18 9---9.493466
So is the Tangent of the Declina. 65.40 10.344652
To the Tangent of 34 deg. 34 min.------19.838118

Whoſe Complement 55 deg. 26 min. is the diſtance of the Meridian and *Subſtile* from the *Horizontal* line.

For the Inclination of the *Meridian* of the *place* from the Meridian of the *Plane*, Thus,

As the Radius, or ſine of 90 deg. 10.000000
Is to the ſine of the Latitude 51 30--- 9. 893544
So is the *Tangent* of the Decli. 65 40---10.344652
To the *Tangent* 59 deg. 55 min. --- 10.237196

Now becauſe 59 deg. 55 min. is almoſt 4 *hours* diſtance from the Meridian, I conclude that the *Subſtile* ſhall fall near 8 of the Clock, on the *Weſt* ſide of the Meridian: Becauſe the *Plane* declineth *Eaſt*.

The Requiſites being found, Draw the *Horizontal-line* D A, then with the *Radius* of your line of *Chords*, deſcribe the Arch A B, and ſet thereon from A to B 55 deg. 26 min. the diſtance of the Meridian or *Subſtile* from the *Horizon*, and draw B D for the Subſtile. Then perpendicular to the Subſtile, draw the lines F G and C E, having found the *Inclination* of Meridians to be 59i deg. 55 min. find it on the *ſecond* Scale, and againſt it on the firſt *Scale* you ſhall find 3 hours 59 min.

Then having recourſe to the Table following, ſet off the *Hours* from K and H, according to the directions of the 27*th* Chapter, for the far decliner, taking the ſeveral diſtances with your Compaſſes out of either of the Polar Scales, and ſetting them off from *K* towards C and E, as the *Table* plainly ſheweth, drawing lines *parallel* to the Subſtile through thoſe points, and thoſe Lines ſhall be the Hour-lines required for that *Plane*.

From K *towards* E.				*From* K *towards* C.			
H.	M.	h. on the	Plane	H.	M.	h. on the	Plane
0	59	K	9	0	1	K	8
1	59	K	10	1	1	K	7
2	59	K	11	2	1	K	6
3	59	K	12	3	1	K	5
4	59	K	1	4	1	K	4

The extent of the Compaſſes from the beginning of the ſame Polar Scale to the Hour of 3, gives the height of the Stile above the Subſtile, which may be a Plate of *Iron* or *Braſs* ſet up juſt over the Subſtile H K; and ſo the Dial is finiſhed.

SECT. I.

How to find what time the Sun *paſſeth from one ſide of an* Equinoctial Plane *to the other.*

EVery *Plane* Reclining to the *Equinoctial* is concident, with ſome Hour-Circle, or part and therefore the *Sun*, in what Paralell paſſeth from one ſide of that *Plane* to the other, at the ſame hour and min. which you may ſee by the following Canon.

As the ſine of the Latitude ——	51.30.9.	89354
Is to the Radius —— ——	90.00.	10.00000
So is the *Co-Tan.* of the Planes decl.	65.40.	9.65534
To the *Tangent* of —— ——	30.00.	9.76180

Which 30.00. being converted into time, giveth 2 hours from Midnight, when the *Sun* paſſeth from the Inclining to the Reclining *Plane*, and reckoned from Noon, when the *Sun* forſaketh the reclining *Plane*, and Shineth upon the *Inclining* ſide again. And thus it continues till the *Northern* amplitude or the *Sun* is equal to 65. 40 the Declination of the *Plane*, from thenceforth it Shines no more upon the Inclining part in the Morning, and when the *Southern* amplitude of the *Sun* is equal to 65. 49, the declination of the *Plane*, then it forſaketh the inclining ſide at Evening alſo, and the reſt of the Year it only Inlightneth the reclining ſide of the Plane.

Note, the *Meridian* in all theſe Planes run *North* and *South*.

CHAP. XV. *Fig. 32.*

How to draw Hour-lines *upon a* South *Reclining* Dial, *declining* Eaſt *or* Weſt, *which paſſeth between the* Pole *and the* Horizon.

THE third Variety in *South* declining reclining Dials, is of thoſe that paſs between the Pole of the World and the *Horizon*; therefore becauſe the Plane falleth between the *North* Pole and the *Horizon*, therefore the *North* Pole is elevated above it; from whence you may conclude that the Center of the Dial muſt be downwards upon the Plane, and the Hour-lines running upward to the *North* Pole.

Example, Let the Latitude of the place be	51.30
The decliuation of the Plane be	33.00
The reclination of the Plane be	55 00

I. To find the Latitude of the Place wherein this Plane ſtands as an upright Decliner.

As the *Radius*	90.00.	10.00000
Is to the Co-ſine of the Old Decli.	30.00.	9. 93753
So is the Co-Tang. of the Declina.	55.00.	9. 84522
To the Tangent of ——	31.14.	19.78275

The difference between this *Tangent* and the Latitude 51. 30, is 20. 16. whoſe Complement 69. 44. is the New Latitude.

II. The refering of this Plane to a New Latitude, doth alter the declination; therefore a new declination muſt be found.

As the *Radius*	90.	00.	10.00000
Is to the Co-ſine of the reclina.	55.	00.	9. 75859
So is the ſine of the Old decl.	30.	00.	9. 69897
To the ſine of the new decl.	16.	40.	19.45756

Having found the new Latitude and new declination, you may find the Subſtiles diſtance from the *Meridian*, the Stiles height, and the Planes difference of Longitude, as you were directed for upright decliners.---- Only *Note*, inſtead of uſing the Old Latitude and declination, you muſt uſe the new Latitude and declination.

The diſtance of the Meridian and Horizon may be found by the directions of the 12*th* Chap. page 98.

Having found the Requiſites, you may frame a Table of Angles at the Pole, according to the Direction of Upright Decliner. —From thence you may find the Hour arches, and ſet them down as you ſee in this Table.

Old Latitude	51	30
Old Declination	20	00
Reclination of the Plane	55	00
New Latitude	69	44
New Declination	16	40
Subſtiles Diſtance from	06	03
Stiles Height	19	25
Planes Longitude	17	42
Meridians Diſtance from the Horizon.	64	41

Hours from the Subſtile.	Equinoctial Diſtances·		Hour Arches.		Hours from the Subſtile.
Eaſt Dial.	d.	m	d.	m.	Weſt Dial.
5	87	22	82	07	7
6	72	22	46	17	6
7	57	22	27	26	5
8	42	22	16	52	4
9	27	22	09	46	3
10	12	22	04	1[illegible]	2
Subſtile					Subſtile
11	02	38	00	53	1
12	17	38	06	02	12
1	32	38	12	01	11
2	47	38	20	01	10
3	62	38	32	42	9
4	77	38	56	35	8

The Geometrical Projection,

1. Draw the Horizontal-Line A B, then on G the Center, with 60 deg. of Chords, deſcribe the Circle AEB, then take 64. 41, the diſtance of the *Meridian* and *Horizon*, and ſet from B to C, becauſe the Plane declines *Eaſtward*, and draw the Line G C, for the *Meridian* or 12 a Clock; then take 06. 03, the Subſtiles diſtance from the *Meridian* and ſet from C to D, on the right-hand of the *Meridian*, becauſe the Plane declines *Eaſtwards*, alſo take 19. 25. the Stiles height and ſet from D to E, and draw G E, for the *Subſtile*, and G E, for the Stile.

Then from the ſame line of Chords you deſcribed your Circle A E B, take 82. 07, 46. 17, 27. 26. 16. 52, 09.46, 04.10, and ſet from the Subſtile D, for the Hours of 5, 6, 7, 8, 9, and 10 in the fore-noon: Then take 00. 53, 06. 02, 12. 01, 20. 01, 32. 42, 56. 25, and ſet from D, the Subſtile, for 11, and 12 at Noon, and 1, 2, 3, 4, in the afternoon, and from C, the Center of your *Dial*, draw lines thro' the ſeveral points, you have the Hour-lines deſired.

Laſtly, Let the Stile make an Angle of 19. 25, above the Plane, and be ſet Perpendicular to the Subſtiler-line G F, and raiſe the Plane to make an Angle of 35 deg. above the *Horizon*, and declining *Eaſt*, 30 deg. it will ſhew the true time of the Day: Wherein *Note*, that having made this one Dial (or any of the like) you have at once made four; changing but the Poſition of the *Dial*, and altering the number of the *Hours*, as the *Plane* doth require, For firſt, this anſwereth to the oppoſite *North* declining 38 deg. *Weſt*, and Inclining to the *Horizon*, 55 deg. alſo the *South* declining *Weſt*, 30 deg. and reclining 55 deg. and to his oppoſite *North* declining *Eaſt* 30 deg. and reclining 55 deg.

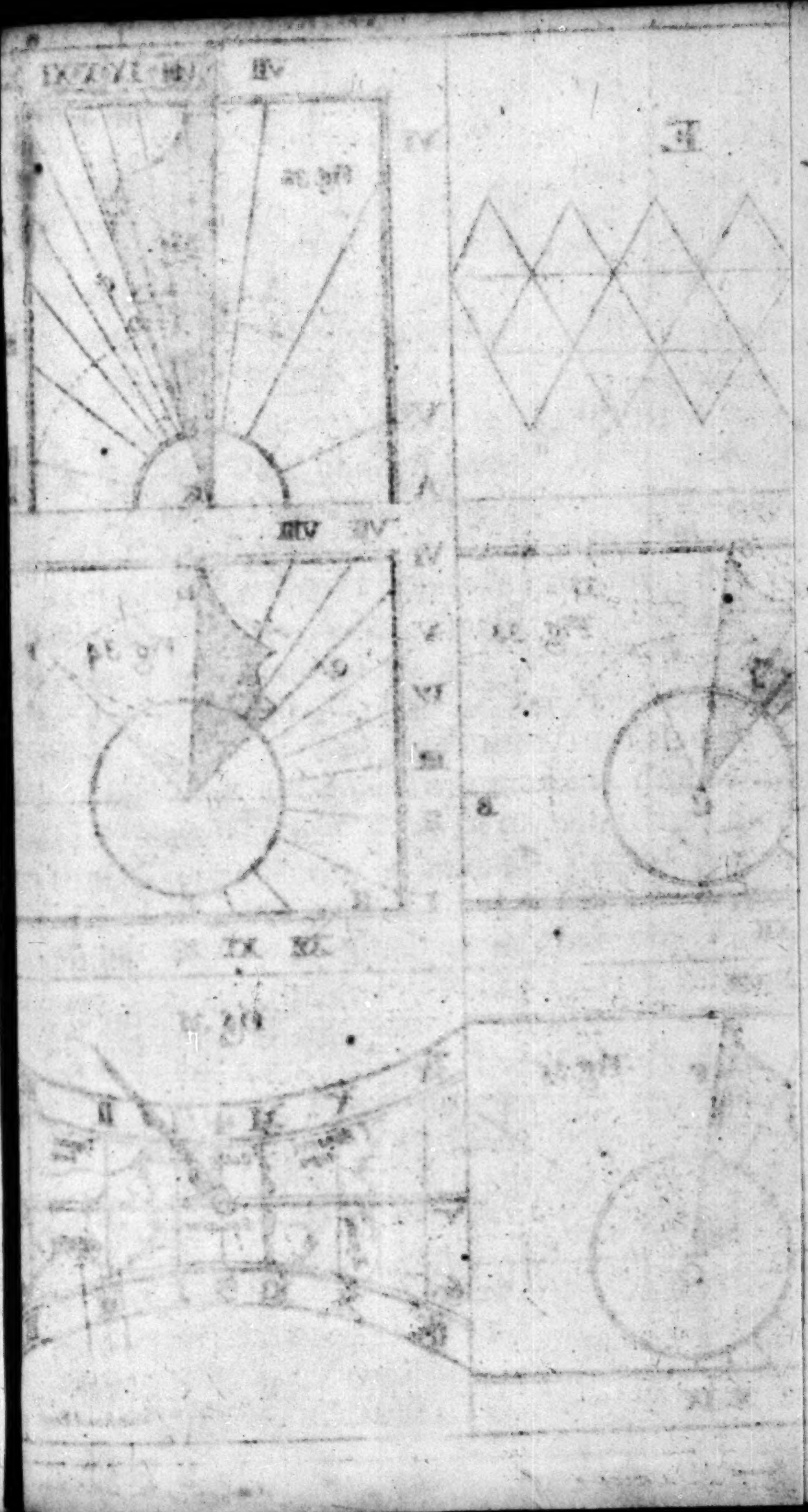
And *Note*, in all *South* recliner more than an *Equinoctial* the Meridian doth aſcend above the *Horizontal* line, at that end which lies the ſame way with the Planes declination.

And in all *North* Inclining declining Planes more than an *Equinoctial*, the *Meridian* doth deſcend below the *Horizontal* line, at that end which lies the ſame way with the Planes declination.

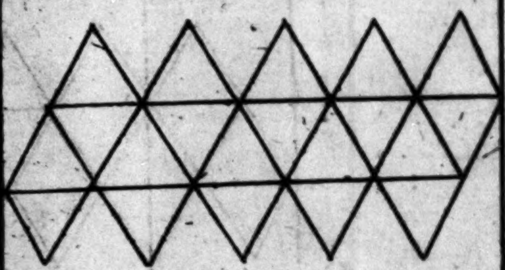
Thoſe *South* Planes are *Equinoctial* decliner, whoſe reclination, and declination maketh them fall into the *Pole* of the World, that is, the *Plane* doth paſs thro' both Polar, and by that reaſon the Stile doth make no Angle with the *Plane*, but doth lie Parallel to it, and thoſe Planes, are ſaid to be leſs than *Equinoctial* Planes that paſs between the Zenith and the *Pole*, and thoſe more than *Equinoctial Planes* that paſs between the *Pole* and the *Horizon*.

Note, that in the Operation (in *South* Planes) in finding the New-Latitude, if that the *Tangent* that comes out be equal to the Latitude of the place, that *Plane is ſaid* to be an *Equinoctial* plane; but if more than the Latitude, it is leſs than an *Equinoctial Plane*; but if leſs than the Latitude, then is it more than an *Equinoctial Plane*.

SECT.



E



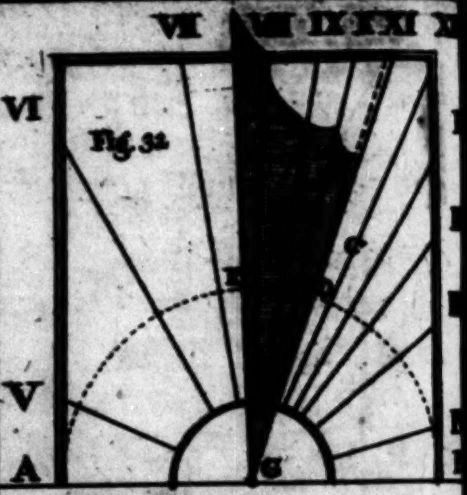


Fig. 32

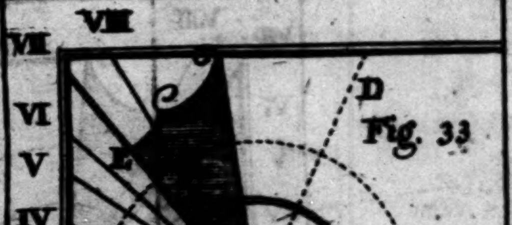


Fig. 33

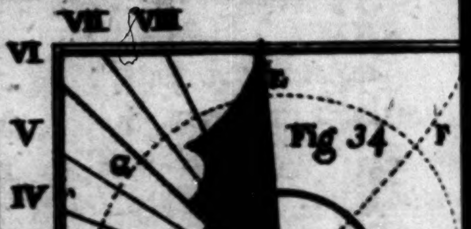


Fig 34

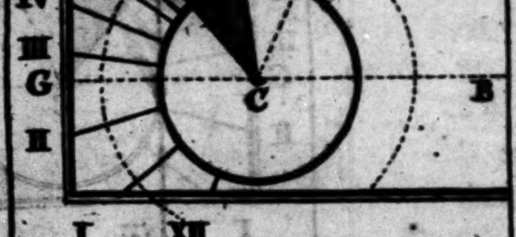


Fig. 35

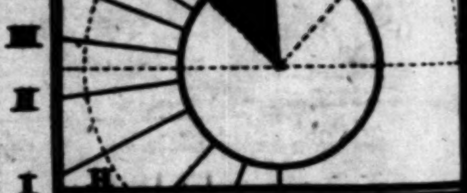


Fig. 36

Whitehead Fecit

SECT. I.

The Latitude *of the place, the* Sun's *Declination, with the Declination, and reclination given, to find what time the* Sun *forſaketh the* South *reclining Plane, to Shine upon the* North *reclining oppoſite thereto.*

AS the Radius	90.00.	10.00000
Is to the *Tan.* of the *S.decl.*	23.30-	9. 63830
So is the *Tan.* of the *Stiles* heig.	19.25.	9. 54713
To the Co-ſine of	81.11.	19.18543

Unto this Co-ſine 81. 11. add the *Planes* Longitude 17. 42, the whole Angle is 98. 53.---90 deg. is 6 hours, therefore 08. 53. reſolved into time giveth no Hours, but 35 min. before 6 at Night, when the *Sun* in *Cancer* forſaketh the *Plane* reclining, to Shine upon the Inclining ſide thereof, or again the Co-ſine 81. 11. reſolved into time giveth 5 Hours 25 min. from Noon, that the *Sun* in the Morning, parteth with the *North* Inclining *Plane*, to Shine on the *South* reclining *Plane*, oppoſite thereto. Thus I have done with *South* reclining *Dials*.

Of North Recliners,

CHAP. XVI. Fig. 23.

How to draw Hour-lines, *upon a North Reclining Declining* Dial *60 deg. Weſtward, and Reclining 16 deg. from the Zenith toward* Equinoctial.

1. *To find the New* Latitude.

AS the *Tan*. of the Planes reclnation 16.30.
C. *Arithmetical* —— —— 0. 54250
Is to the *Radius*—— —— ——90.00. 10.00000
So is the Co-ſihe of the Planes decl. 60.00. 9.69897
To the Co-Tangent of—— ——29.50. 19.24147

This *Co Tangent* being compared with the Latitude, 51. 30, there difference 21. 40, is the new *Latitude*.

2. To find the New *Declination*.

As the *Radius* —— —— ——90.00. 10.00000
Is to the Sine of the Declination, 60.00. 9. 93753
So is the Co-ſine of the Reclina. 16.00. 9. 98284
To the ſine of the New declina. 56.40. 19.92127

3. To find the diſtance of the *Mer*. and *Horizon*.

As the Radius —— —— —— 90:00--10.00000
Is to the Sign of the *Reclinat*. 16:00. 9. 44033
So is the Tangent of the Old decl. 60.00. 1023856
To the *Co-Tan*. of the diſt. of the Meridian and Horizon, } 64.29. 19.67889

The Latidude of the Place—— —— ——51. 30
The Reclination of the Plane —— ——16. 00
The decl. of the Plane from the *NorthWeſt*. 66 00
The New Latitude —— —— — 21. 40
The New Declination in that Latitude, 56. 21
The diſtance of the Mer. and Horizon, 64. 29
The diſtance of the Subſtile from the Mer. 64. 28
The Stiles height above the Plane, —— 30. 59
The Planes difference of Longitude —— 76. 10

Having found theſe things, as you were directed formerly, you may proceed to the making of a Table of *Equinoctial* diſtances, and ſo Calculate the true Hour diſtances, as you were Taught in upright Decliners, and they will be as followeth.

The *Geometrical* Projection,

Weſt Decliner.	*Equinoctial diſtances*		*True Hours diſtance.*		*Eaſt Decliner*
Hours	*d.*	*m.*	*d.*	*m.*	*Hours*
1	88	50	87	44	11
2	73	50	60	37	10
3	58	50	40	24	9
4	43	50	26	18	8
5	28	50	15	49	7
6	13	50	7	13	6
Sbuſtile	—	—	—	—	*Subſtile*
7	1	10	0	36	5
8	16	10	8	29	4
9	31	10	17	18	3
10	46	10	28	12	2
11	61	10	43	5	1
12	76	10	64	26	12

Draw an Horizontal Line almoſt in the middle of the Plane, as A C, B, then chuſe a place in the *Horizontal line* for a *Center*, as at C, and with 60 deg. of Chords make the Circle A, B, G, from the *Eaſt* Point of the *Horizontal line* A, by help of a line of Chords, ſet A, 12. 64, 29. the diſtance of the *Meridian*, and *Horizon*, for the *North* part of the *Meridian*, or, more properly from B, the *Weſt* point of the Horizontal line upwards to D, the *South* part thereof, and draw the line D C, 12. for the 12 a Clock *Hour-line*; from D to E, ſet 64. 21. the diſtance between the Subſtile and the *Meridian Eaſtwards* from it, and draw the pricked line C E, for the *Subſtile*, from the point *E*, in the Subſtile, by help of a Line of Chord, ſet off the True Hour diſtances both ways in the Circle towards *G*, and *D*, as you find them in your *Table*; unto every prick draw ſtreight Lines from *C*, to the Centre, ſo ſhall you have all the hour Lines proper for this Dial.

Laſtly, from *E*, to *F*, ſet off the height of the ſtile 30:59, and draw the Line *C*, *F*, repreſenting the *Axis*, which being erected at right *Angles* over the *Subſtile C*, *E*, and muſt point upwards toward the *North* Pole, ſo is the *Dial* fit for Uſe, and muſt be placed according to the *Declination* and *Reclination* of the *Dial*.

Note, In Declining Reclining leſs than a Polar, the Meridian aſcends above the Horizontal Line, the ſame way with the Coaſt of Declination, and repreſents 12 a Clock at Night; and in the *South* Declining Inclining Dial leſs than a Polar, the *Meridian* doth deſcend below the *Horizontal* Line the ſame way with the *Declination*.

SECT. I.

How by having the Lat. *of the Place, the* Sun*'s Declination, the Declination and Reclination given, to find what Line the* Sun *parteth from the* South *Incliner. to Shine upon the* North *Recliner, oppoſite thereto.*

As the *Radius* —— —— ——	90.	10.00000
Is to the *Tang.* of the *Sun*'s decl.	23.30.	9.63830
So is the *Tang.* of the Stiles height	30.59.	9.77848
To the *Co-Sine* of —— ——	74:52	19.41678

Out of the *Planes* Long. 76 : 10, take 74 : 52, there will remain 1 deg. 18 min. which converted into *Time*, giveth only 5 min. before Noon, when the *Sun* forſaketh the Inclining ſide of the *Plane*.

CHAP. XVII. *Fig.* 34.

How to draw Hour Lines *upon a* Polar Dial, *Declining* Eaſt *or* Weſt 60 *deg. and Reclining* 32:11.

BEfore I ſhall ſhew how *Hour Lines* are to be deſcribed on theſe *Dials*, I ſhall ſhew, how having a *Declination* given, to find a *Reclination* that will make it a *Polar Declining Dial:* Or having the *Reclination* given, to find what *Declination* will do the like.

The *Canon* for *Calculation.*

As the Co-Tan.of the Lat.Com.Arit.51:30.0.09939
Is to the Radius ——— ——— 90:00—10.00000
So is the Co.Sign of the *Planes De.*60:00—9.69897
To the Tan. of the *Reclination.* 32:09—9.79836

Again,

As the *Radius* ———. ——— 90.00. 10.00000
Is to the *Tang.* of the Reclination. 32.09. 9.79830
So is the *Co-Tang.* of the Latitude 51.30. 9.90060
So is the Co-ſign of the *Decl.*requ. 60:00—9.69890

In theſe ſort of *Planes* you have only the height of the *Stile* above the *Subſtile*, and the diſtance of the *Meridian* to find; now foraſmuch as the diſtance of the *Subſtile* from the Meridian is 90:00, and by that reaſon the *Plane* is an upright *Plane* where there is no *Latitude*, therefore the diſtance of the *Equator*, from the *Pole* being 90:00, alſo; therefore the *New Declination* will be equal to the height of the *Stile*, which you may find by the following *Canons*.

As to the *Radius*. —— ——	90:00	0.00000
Is to the *Sine* of the *Planes* Decl.	60:00	9.93753
So is the Co-ſine of the *Reclin*.	32:09.	9.92770
To theCo-ſign of the*PlanesnewDe*.	42:52.	19.86520

Which is the Height of the *Stile* above the *Subſtile*; alſo you may find the diſtance of the *Meridian* and *Horizon* by this *Canon*.

As the*Co-Ta*.of the *PlanesDecl*.C.A.	60:00.	0.23856
Is to the *Radius* ——	90:00.	10.00000
So is the *Sine* of the *Planes Recli*.	32:09.	9.72602
To the *Co-Tangent* of —	47:20.	9.96458

The *Latitude* of the *Place* ——	51:30
The *Declination* of the *Plane* ——	60:00
The *Reclination* of the *Plane* - - - - -	32:09
The *New Latitude* - - - - - - - - - - - -	00:00
The *New Declination* in that *Lat*. - - - -	42:52
The *Diſtance* of the *Subſtile* from the *Mer*.	90:00
The *Height* of the *Stile* above the *Plane*	42.52
The *Planes* Difference of *Longitude* - - - -	90.00
The *Diſt*. of the *Meridian* and *Horizon*	47.20

Hence you may ſee the *Planes* Difference of *Longitude*,

Longitude, being 90 deg. the *Subſtile* muſt be the 6 a Clock Hour-Line, and the Hour Angles on either ſide of the Hour of Six is equal, therefore it is but the adding or 15 deg. on either ſide the *Subſtile*, and you have a Table of *Equinoctial* diſtances, and from thence you may Calculate the True Hour, as you where Taught in *Upright Decliners*. The *Table* followeth.

The *Geometrical* Projection.

Hours from the Subſtile	*Equinoctial diſtance.*		*True Hour diſtance.*		*Hours from the Subſtile.*
Hours	*d.*	*m.*	*d.*	*m.*	*Hours*
6	*Subſtile*		*Subſtile*		6
5	15		10	20	7
4	30		21	27	8
3	45		34	14	9
2	60		49	41	10
1	75		68	30	11
12	90		90	00	12

The *Table* being prepared, draw the Horizontal Line *A*, *C*, *B*, near the middle of the *Plane* and *Parallel* to the bottom, in any part thereof, at the *Centre* C, with 60 deg. of Chords draw the Circle *H*, *G*, *E*, *F*, and ſet 47.20 the diſtance of the Meridian and Horizon, from *B*, the *Weſt* end of the *Horizontal* Line to *F*, upwards, and draw the Line *F*, *C*, *D*, for the Hour of 12, then ſet 90 deg. the *Subſtiles* diſtance from the *Meridian*, from F, to G, and draw C, *G*, for the *Subſtile* and *Hour Line* of *6*, ſet off from *G*, each way, by help of a Line of Chords upon the Circle *E*, *G*, *H*, the *Hour* diſtance, as you find them in the *Table*, viz. for the *Hour* of 5, and 7, 10 deg. 20 min. for 4, and 8, 21 deg. 27 min. and ſo of the reſt; (but paſt 8 you need add no more,) ſo ſhall you have *Points* unto which ſtreight Lines being drawn from the *Centre*, are the true *Hour Lines* on the *Plane*.

Laſtly, From G, either way ſet off the height of the *Stile* 42 deg. 52 min. from G, to E, and draw the *Line* C, E, for the *Axis* of the World, which being Erected *perpendicular* over the *Subſtile*, the *Dial* is finiſhed; but obſerve that your *Dial* be ſet to its true *Declination* and *Reclination* proper to the ſame.

Note, The *Meridian* in all *North* Declining Polar Dials, deſcend below the *Horizontal* Line, at that end which is contrary to the Coaſt of the Declination: And the *Meridian* in all *South* Declining Polar Dials, doth deſcend alſo from the contrary Coaſt of Declination, and the ſix a Clock hour Line is always the *Subſtile* in both.

SECT. I.

The Latitude *of the* Place, *the* Declination *of the* Sun, *together with the* Reclination *and* Declination *given to find what time the* Sun *forſaketh the* South *Inclining ſide, to ſhine upon the* North *Declining ſide, oppoſite thereto.*

As the Radius,	——	90 : 00.	10.00000
Is to the *Tan.* of the *Sun's Decl.*		23 : 30.	9.63830
So is the *Tan.* of the *Stiles* heig.		42 : 52.	9.96762
To this Co ſine,	——	66 : 12.	9.60592

Out of the *Planes* Longitude 90 deg. take 66.12, there will remain 23.48, which converted into time, giveth one hour 35 min. before Noon, when the *Sun* leaveth ſhining on the Inclining, and ſhineth upon the Reclining ſide.

CHAP. XVIII. Fig. 35.

How to draw the Hour-Lines upon a North Dial *declining* 60 *deg.* Weſt, *and reclining* 54 *deg. which cutteth the Meridian between the Equinoctial and the Horizon.*

THE making of this *Dial* differeth little from the former, therefore find the Requiſites as you did in the former, that is firſt the New Latitude add New Declination find the diſtance of the Meridian and Horizon, and the Subſtiles diſtance from the Meridian, the Stiles height above the Plane, the Planes Longitude; and Hours diſtances as you have been taught in the former Chapters.

I ſhall not trouble you with Calculating the Requiſites from this Plane; becauſe they may be found by the laſt Chapter but one, and therefore it is needleſs to ſay any more about them, but they are Calculated, and are as following.

The Latitude of the Place	51.50
The Declination of the Planes *Weſt*	60.00
The Reclination of the Plane	54.00
The Plane's new Latitude	18.30
The Plane's new Declination	30.36

The diſtance of Meridian and Horizon	35.31
The Subſt. diſtance from the Mer. 123.09. or	56.41
The Stiles height --- --- ----	54.43
The Plane's Longitude 118:13. or ----	61.47

Having the Plane's difference of Longitude, you may frame a *Table* of Equinoctial diſtances, and find the Hour diſtances, and place them as in this *Table* following.

The *Geometrical* Projection.

Hours.	*Equinoctial diſtance.*		*True Hour diſtance.*		*Hours.*
	d.	*m*	*d.*	*m.*	
12	61	48	56	41	12
11	46	48	40	49	1
10	31	48	26	50	2
9	16	48	13	50	3
8	1	48	1	97	4
Subſtile					*Subſtile*
7	13	12	0	51	5
6	28	12	23	39	6
5	43	12	37	29	7
4	58	12	52	48	8
3	73	12	69	43	9

Draw the *Horizontal* Line *D*, *C*, *A*, about the middle of the Plane, Parallel to the bottom, then at *C*, as a *Centre* with 60 deg. of Chords deſcribe the Circle *F*, *D G*, and from the *Eaſt* point of the *Horizon* from *B*, to G, ſet 35.31. the Diſtance of the *Meridian* and *Horizon*, and draw the Line *C*, *G*, for the Twelve a Clock hour Line, then ſet off 56: 41. the Subſtiles diſtance from the Meridian from G, to *D*, and draw the Line *C*, *D*, for the Subſtile, and ſet off 54.46 from *D*, to F, for the Stile, ſo ſhall *D*, F, be the Stiles height above the Plane;

then ſet the *Hour* diſtances from the Subſtile both ways, as you find them in the *Table* (as you have been taught in the foregoing Chapters) and thro' the Points draw Lines, and ſet the Stile right over the Subſtile, and then have you finiſhed four ſeveral Dial. This for one, and his Oppoſite Inclining 54 deg. to the *Horizon*, and Declining *East* 60 deg. and his Oppoſite *South* Inclining 54 deg. and Declining 60 deg. *Weſt*, only turning the Dials upſide down, and changing the Figures of the *Hours* for Forenoon and Afternoon, as the Dials will direct you; and ſo may be done to all Dials whatſoever, except the direct *Eaſt*, or *Weſt*; for there can be but two, for the backſide of the *Eaſt*, is the *Weſt*.

Note, The Meridian in all *North* Recliners more than at Polar (as this is one) doth deſcend below the *Horizontal* Line, and from that end which lies contrary to the Coaſt of the Plane's Declination, and in the *South* Inclining and Declining more than a Polar, the Meridian doth aſcend above the *Horizontal* Line, contrary to the Coaſt of the Declination, and is only ſerviceable to help to draw the Dial.

Note alſo, In the *North* Reclining Declining Dials, if that Tangent that comes out in finding the new Latitude be equal to the Complement of the Latitude of the Place, then is that a Polar Plane, if the Complement of the Latitude exceed the Tangent, then is the Plane leſs than a Polar, but if the Tangent found, doth exceed the Complement of the Latitude, then is the Plane more than a Polar Dial.

SECT.

SECT. I.

Having the Latitude *of the* Place, *the* Sun's *Declination, with the Declination, and Reclination of the* Plane, *given to find what time the* Sun *forſaketh the* South *Inclining ſide to ſhine on the* North *Reclining ſide Oppoſite.*

As the Radius,		90.00.	10.00000
Is to the *Tang.* of the *Sun's Decl.*		23.30.	9. 63830
So is the *Tang.* of the Stiles heig.		54.43.	10. 15021
To this Co-ſine of		52.05.	19.78851

Unto the Angle 52.05, add the Plane's Longitude 61.47, from the *North*, or out of the Angle 118.13, counted from the *South*, there remains 66.08, which converted into Time, giveth 4 hours, 14 minutes before Noon, when the *Sun* forſaketh the Inclining ſide of the Plane, and ſhineth upon the Reclining ſide thereof.

CHAP. XXI. Fig. 12 & 13.

Directions for making Two ſorts of SPOT-DIALS, *very uſeful to ſhew the* Hour *within the* Houſe.

A Deſcription of the Spot-Dial.

THE *Spot-Dial*, is of two ſorts; in the one a bright Spot goes to the Lines, in the other the Lines go to a black Spot; the former being explained,

plained, the latter cannot be unknown. The manner of drawing the Hour-lines, is the ſame was ſhewed on any other Dials, in the foregoing Chapters; but conſider, if there was an Axis or Stile on this Dial, it would paſs through the Back-board (which all ſuch Dials muſt have) and the very Point where the Axis doth go through, is the Place where a hole in the one, and a ſpot in the other is to be made, that at any time [the *Sun* ſhining] will ſhew you the Hour of the Day.

SECT. I.

For the making of theſe Dials.

1. Get the Joyner to make you a moulded wooden Frame, with miter-joynts, like the frame of a Looking-Glaſs, or ſuch a Gilt Frame, as are made for Pictures; about 8 Inches long, 5 Inches broad and an Inch and half thick, and nail upon one of the longeſt edges of the Frame a piece of thin Board a little longer then the Frame, and but half as broad: This piece of board is for the bottom, and be ſure that your Frame ſtands exactly perpendicular upon the bottom piece: Then for the back of your Frame, get a thin plate of Wood, exactly fit for it, and at the top of this Plate of Wood make a hole about 3 Inches long, and two Inches broad, and upon that nail a piece of Tin, or rather Copper-Plate.

2. You muſt get a piece of Crown Glaſs fit for your Frame, and grinde one ſide of it till it is as lucid as Paper, thus: Lay your Glaſs upon a Lin-

nen, or Wollen Cloth to keep it from breaking; then with a ſmall piece of Glaſs, and *Calice-Sand* grinde your Glaſs, but you muſt have a great care not to grinde the other ſide; for in little time you may ſo ſmutch the Glaſs by heedleſs miſtake of the ſide, as to make it uſeleſs.

3. Having found the Declination of your *Glaſs-Window*, againſt which it is to ſtand, make a Dial exactly the bigneſs of your Glaſs upon Paper, to that Declination, with *Stile* and *Subſtile* drawn upon the Paper, as if you were to make it for the Wall without Doors, or outſide of the *Window:* but the Figures of this *Paper-Dial* muſt be inverted, or made backward as in Figure 13; and if you Write in *Roman Letters*, for Nine you muſt Write Eleven; and therefore your beſt way is to have a Copy before you, of Figures ſo drawn.

4. Now to find where the Spot will be; remember that it will be always in the *Subſtile*, and as far diſtant from the *Stile*, as is the diſtance between your Glaſs and the Tin: Put therefore your Glaſs already ground, into the Frame, and take the neareſt diſtance between your Glaſs and Tin; for this end make a ſquare of Paper; and applying one ſide to the Glaſs as it lies in the Frame, make a point at the neareſt diſtance, and clip off the reſt of the Paper at that point; with that diſtance come to your Dial on the Paper, and lay the longeſt edge of this ſquare to the *Subſtile*, and carry it backward or forward upon the *Subſtile*, till the marked point juſt toucheth the *Stile*; then holding it, draw a line from the *Subſtile* to the *Stile*, and mark that point upon the *Paper-Dial*, where this Line cutteth the *Subſtile*, viz. at the corner of

the ſquare, (which I call the *Subſtile-point*) and draw a round ⊙ about it, that you may know it again.

5. Having drawn your *Paper-Dial* the Exact bigneſs of your Glaſs, and found your *Subſtile-point*, you muſt draw the *Hour-lines* upon the rough ſide of the Glaſs, thus: Wet the Figured ſide of your *Paper-Dial* with Gum-water, and lay it on the ſmooth ſide of your Glaſs; and when it is dry, ſet one Foot of your Compaſſes upon the Center of the *Dial*, and open the other to the *Subſtile-point*; with that diſtance deſcribe a *Semicircle*, and from that *Semicircle* draw all your *Hour-lines* with a Pen and Ink, by the ſide of a Ruler upon the rough ſide of the Glaſs; your Figures muſt be drawn wrong as they appear through the Glaſs, which you will find to be right when your *Dial* is in the Frame, and finiſhed.

6. Mark your *Subſtile-point* upon your *Glaſs*, and take off your *Paper-Dial*.

7 Make faſt your *Glaſs* in the Frame with ſmall Tacks, the rough ſide next the *Back board*.

8. Make a little hole in the Tin, perpendicular over againſt the *Subſtile-point*, which you will find by the *Paper-ſquare*; by which you may draw a perpendicular Line from the *Subſtile-point*, and Ink it upon the Top of the Frame, and ſo draw it down your *Back-board*; then take the diſtance from the *Subſtile-point* to the outermoſt Edge, or Top of the Frame, and ſet it upon your line drawn on your *Back-board*, from the Top downwards, which diſtance will be perpendicular over your *Subſtile-point*.

9. *And Laſtly*, with *White.Lead* and *Linſeed-Oyl*

Oyl ground together, Paint the rough ſide of the *Glaſs*; then glue on your *Back-board*, and your *Dial* is finiſhed.

Now your *Dial* being made, ſet it cloſe to your *Glaſs-Window*, and the *Sun* entring thro' the little hole, will caſt its Ray upon the oppoſite *Hour-lines*, and ſo give the time of the Day.

I need not ſay much of that Form, wherein the Lines go to the *Spot*, for it is but the ſame inverted, as if you ſhould turn this upſide down, and draw the Lines towards *Window* or *Street*, upon a clear *Tranſparent Glaſs*, and on the inſide toward the *Houſe*, inſtead of the Plate of *Wood*, and the *Tin*, you muſt have a *Glaſs* ground, with one black *Spot* at the bottom, where the hole is in the *Tin*, unto which *Spot* every Line will come ſucceſſively, according to the time of the day; and the Figures muſt be made upon the clear *Glaſs* at Top; and there muſt be a great ſquare Quarry of Glaſs in the *Window* behind it; for the *Leads* will make a very unhandſome Confuſion.

SECT. II.

How to draw Hour-Lines *upon the* Window-board, Walls, *and* Floor *of a* Room, *the* Sun *ſhining through a ſmall* Hole *made in any* Pane *or* Quarry *of* Glaſs *in the* Window.

FIrſt, if in the *Glaſs-Window* of any *Room*, one *Pane* or *Quarry* of *Glaſs* be darkned, and a *Hole* made about half a quarter of an Inch *Diameter* in the middle thereof, the *Sun* ſhining upon the *Window*,

Window, will through that hole caſt a bright *Spot* of *Light* into the *Room*, which as the *Sun* in his motion paſſeth by the *Window*, the *Spot* of *Light* will be alſo removed from place to place, ſometimes upon the *Window-board*, ſometimes upon the *Jambs*, ſometimes upon the *Sides*. and ſometimes upon the *Floor* of the *Room*: If ſuch a *Hole* ſhould be ſuppoſed to be the *Nodus* or *Point* of the *Top* of the perpendicular *Stile* of any *Dial*, I ſay from it the *Hour-lines* of a *Sun-Dial*, or of ſeveral *Dials* [for every ſide or part of the *Room* is a different *Plane*] may be made about the *Room* If,

1. *Horizontally* you apply an Horizontal-Dial to the Hole in the *Glaſs-Window*, and extend a thread Horizontally alſo from that Hole, over every Hour-line [or half and quarter Hour-line] till it touch the *Sides*, Doors, *Windows*, *Jambs*, or other *Objects* or I*mpediments* [ſtanding in the way] about the *Room*: Then,

2. The *Twelve* a Clock Hour-line, being both an *Hour-line*, and an *Azimuth* alſo; you may [by a perpendicular Thread, or Threads,] transfer the ſame to the *Cieling* or *Floor* of your *Room*, or to which of them will beſt ſerve your Turn, and ſometimes there may be occaſion for both: Then,

3. In this *Meridian Line* find any *Point*, from which a Line or Thread extended to the *Hole* in the *Window*, may repreſent either the Direct [or Reverted] Axis of the *World*, and unto that *Point* or *Points*; all the *Hourr-lines* which you draw in that *Room* will have reſpect unto, [or be in the ſame *Plane* with] this *Axis*: and therefore,

4. If you fix a Thread in one or both of theſe

Points, [or *Poles* rather] and extend that *String* by the ſide of another *String*, extended from the *Hole* over any *Hour-line* or *Point*, found on the ſide of the *Room* [as before] that moveable *String* being gently moved by the ſide of the *Horizontal String*, ſhall trace out [upon all *Objects* that it meets withal] the *Hour-lines*, which the extended *Horizontal-String* doth repreſent.

CONCAVE DIALLING

CHAP. XXII.

How to draw Hour-lines in the Inſide of Regular Concave Hemiſpheres.

THeſe *Regular Concave Hemiſpheres* are the moſt natural *Planes*, upon which *Hour-lines* may be deſcribed, for they do naturally repreſent the *Sphere*; and the manner how the *Hour-lines* and *Furniture* may be deſcribed, into ſuch Dials, ſhall be the Work of this and the next Chapter.

SECT. I. Fig. 14.

To make a Horizontal Concave Dial.

HAving a *Concave Hemiſphere* prepared: as, S. N. E. W. divide the Limb into 4 Quadrants, noted as the former Letters; one of the Quadrants divided into 90 deg. open your Compaſſes to the Quadrant, and ſetting one Foot upon E. or W. with the other, draw the *Meridian* or 12 a Clock *Hour-line* SZN take out of the Quadrant, the *Latitude* 51 deg. 30 min. and ſet thoſe degrees upon the *Meridian* from S, towards Z to P, which P, ſhall be the *Pole* of the World; then placing your Compaſſes upon P, (they being opened to a Quadrant) draw the *Equinoctial Circle* EÆW, which divide into 12 equal parts; your Compaſſes being opened as before to a Quadrant, and one foot being placed in thoſe marks, made in the *Equinoctial*, with the other foot deſcribe Circles, which ſhall be the Hour-lines required; the *Stile* muſt be erected in P, with an Angle of 51 deg. 30 min. the *Latitude* of the place; and equal to the length of 60 deg. of the Quadrant, the Top muſt hang over the Center of the *Hemiſphere* Z, and be parallel with the Limb, or erect a Stile in the Point *Z*, of the ſame length with the former, which ſhall ſhew the hour with the Top only.

SECT. II.

How to make a Direct South or North Concave Dial.

THIS Dial is made altogether like the former only inſtead of ſetting off the *Latitude* from S to P, you muſt only ſet off the Complement of the *Latitude* 38 deg. 30 min. and the *Hour-lines* only from 6 to 6, are deſcribed thereon; the

reſt

reſt of the *Hour-lines*, are reſerved for a *Direct-Dial* beholding the *North*.

SECT. III. *Fig.* 15.

How to make a Direct East or West Concave Dial.

LET the *Hemiſphere* be ZSNG, the Limb being divided into four Quadrants, and one of them into 90 deg. from N, upwards, and from S, downwards, ſet the *Latitude* to P, then open your Compaſſes to a Quadrant, one foot being ſet in P, with the other draw the *Circle* QEA, which *Circle* divide into 12 equal parts, your Compaſſes being opened to a Quadrant, one foot placed in each of theſe marks, with the other draw Circles, which ſhall be the *Hour-lines* required, as in *Figure* 15, The *Stile* may be a *Wire* laid from P to P, or a *Wire* erected in the Center E, equal to the Semidiameter of the Quadrant; for better Inſtruction ſee the Figure, which is an *Eaſt Dial*.

In the ſame manner is an Equinoctial Dial made, only all the hours from 6 in the Morning till 6 at *Night*, muſt be drawn, as the reſt above thoſe proper for the *Eaſt* or *Weſt* Dials are, and as the pricked hours 9 8 7 and 6, in the Figure.

Alſo the Hour-line of 6, *viz.* the Line P 6 P, muſt be P 12 P, and the reſt number'd as in the Figure is expreſſed, and number'd with *Arithmetical* Figures.

SECT.

SECT. IV. *Fig.* 16.

How to make a South or North Declining Concave Dial.

YOUR *Concave* being prepared, quartered and marked with the Letters ZNEW, your Compaſſes being opened to a Quadrant, and one foot in Z or N, draw the *Horizontal* Circle ESW, take the Declination, and prick it down in the Horizontal Circle from W to H, one foot of your Compaſſes remaining in H, and being opened to a Quadrant, deſcribe the *Meridian*, or hour of 12, in which from Z, ſet off the Complement of the *Latitude*, or from it's interſection with the Horizontal Circle, ſet off the *Latitude* to P, one foot of your Compaſſes being in P, and opened to a Quadrant, draw the Equinoctial QÆA and where it is interſected by the hour of 12, begin to divide it into 12 equal parts, one foot of your Compaſſes being placed in each of theſe *Points*, and being opened to a Quadrant, draw *Lines* which ſhall be the Hour-Lines required. For the Stile, that muſt be erected in P, and the top of it muſt paſs through the Center, of the *Limb* of the *Concave*, and be equal to the length of 60 deg. of the Quadrant, or you may erect the Stile, in the point S, the length equal to the former; which will ſhew the hour of the day with the very top of it.

Note, This Figure Declines *Weſt*; which if it had declined *Eaſt*, the declination muſt have been ſet from E.

SECT. V.

How to make a Polar Concave-Dial.

A *Polar Concave Dial*, is nothing but an *Horizontal-Dial*, in the *Latitude* of 90 deg. and of all others is moſt eaſie to be made, for if you divide the Limb of the Concave *Hemiſpheres* into 24 equal Parts, and from the Center of the Concave, (by help of a thin Ruler that will bend) draw ſtreight Lines to each of them, thoſe ſhall be the Hour-lines required.

For the *Stile*, it muſt be a ſtreight Wire erected Perpendicular in the Center of the Concave, whoſe ſhadow will at all times (the *Sun* ſhining) give the hour of the Day, and the hours of theſe *Dials*, muſt be numbred from 12 to 12.

OF THE FURNITURE *in* CONCAVE DIALS.

CHAP. XXIII.

SECT. I. *How to draw the Parallels of the Sun's Declination, in the foregoing Concave Dials.*

THE *Equator* being drawn, ſet off the degrees of Declination from the *Equator* in the *Meridian*

ridian of the Concave or *Subſtiler*, both upwards and downwards; then place one foot of your Compaſſes in the Pole, and extend the other to thoſe you marked from the *Equator*, draw Circles, which ſhall be the Parallels of the *Sun's* Declination required; As for *Example*, the drawing of the two *Tropicks*, which declines 23 deg. 30 min. from the *Equator*; take 23 deg. 30 min. and prick it down in the *Meridian* both ways, then place one foot of your Compaſſes in the Pole, and with the other extended to 23 deg. 30 min. deſcribe the two *Tropicks*; as in *Figure* 1. appears.

SECT. II.

How to draw the Azimuths or Vertical Circles.

DIvide the *Horizon* into 180 deg. beginning where it's interſected by the *Meridian*; if you would draw every 10*th Azimuth*, then you may only divide it into 18 equal parts, beginning at the ſame place; but if you would only draw every 15 *Azimuth*, then divide the *Horizon* into 12 equal parts, beginning as before at the *Meridian*, if you would draw the Points of the Compaſs, divide the *Horizon* into 16 parts, then open your Compaſſes to a Quadrant, place one foot in any of thoſe *Diviſions*, and where the other foot interſects the *Horizontal* Line, ſhall be the Center for drawing that *Azimuth*.

SECT. II.

How to draw Planetory or Unequal Hours.

FOR the drawing of the *Planetory Hours*, having firſt deſcribed the *Horizon*, *Equator*, and the two *Tropicks*, divide that part of the *Tropick* which is intercepted betwixt its interſection with the Horizontal-Circle, into 12 equal parts beginning at 12; the *Equator* being before divided into 12 equal parts by the Hour-lines, open your Compaſſes to a Quadrant, one foot being placed in one of thoſe Diviſions, move the other foot until you find the Center, which will draw both thoſe Points into one Circle; and draw Circles which ſhall be the unequal Hours required.

SECT. IV.

How to draw Hours from Sun Riſe, to Sun Set, called the Italian and Babyloniſh Hours.

PLace one foot of your Compaſſes in the *Pole*, and extend the other to the interſection of the Horizon and Meridian, and deſcribe the Parallel of the Latitude, which ſhall be divided into 24 equal parts by the Hour-circles, place one foot of your Compaſſes in each of thoſe Diviſions (the Compaſſes being opened to a Quadrant) the other foot, being placed within the Circle of *Latitude*, and in the Hour-circle, which paſſeth through the

Points where the Compaſſes is ſet in the Circle; making that the Center, deſcribe Circles from one *Tropick* to another, which ſhall be the Hour-lines from *Sun Riſe* to *Sun Set*; and ſhall paſs by the interſection of the Hour-lines and the *Equator*.

SECT. V.

How to draw the Almicanters.

Having found the *Points* of *Zenith* and *Nadir*, the diſtance of theſe *Points* to the Horizontal-line into 90 deg. one foot being placed on one of thoſe *Points*, the other extend to thoſe degrees, Circles drawn from one Tropick to another, ſhall give *Almicanters* or Circles of *Altitude*.

CONVEX DIALLING.

CHAP. XXIV.

How to make a Dial, upon the Convex Superficies of a Globe which ſhall ſhew the Hour, by the Shadow, which ſeparateth the Enlightned Hemiſphere from the Opacus.

THE Performance of this is very eaſie, for (the *Globe* being truly *Spherical*) if the *Equinoctial Circle*, the two *Tropicks*, and the two Polar *Circles* which will be neceſſary for ornament only to be deſcribed thereon, and your *Equinoctial Circle*

Circle (or middle of your *Globe* which is all one) be divided into 24 equal parts, and marked wit 1, 2, 3, *&c.* to 12. and then beginning agai with 1, 2, 3, *&c.* to 12. Then if you *Elevat* one of the Poles ſo many degrees above an *Horizontal Line*, as the Pole of the *World* is *Elevate* above your Horizon, and place one of the Hou Points, that is marked with 6, to behold the *Meridian* of the place, then will the two 12 of th Clock Hour-points behold one the *Eaſt* and th other the *Weſt* part of the Horizon; and then th *Sun*, at all times ſhining upon the *Globe*, will Enlighten one *Hemiſphere*, and the other will b Shadowed, and where the Line of Shadow falleth amongſt the Hour-points upon the *Equinoctial*, i will ſhew the Hour of the Day, in two places *viz.* one on the *Eaſt*, and another on the *Weſ* ſide of the *Globe*.

Note, If you open your Compaſſes to a Quarter of the diſtance, round the *Equinoctia Circle* of your Globe, and place one foot in th marks made in the *Equinoctial*, with the othe you may deſcribe the *Hour-lines*, from one *Tropick* to the other, or if you will from one *Pole* t the other.

TABLE *containing the* Latitude, *of moſt of the Eminent* Cities *and* Towns *in* England, Scotland *and* Ireland.

Places in *England* and *Wale*	D.	M.	Places in *England* and *Wales*	D.	M.
ONDON	51	30	*Rocheſter*	51	29
rk	54	00	*Peterborough*	52	33
ford	51	54	*Chicheſter*	53	50
mbridg	52	17	*Hertford*	51	51
rwich	52	44	*Newark*	53	2
nterbury	51	27	*Stafford*	52	55
iſtol	51	30	*Shrewsbury*	52	48
lcheſter	52	4	*Lancaſter*	54	8
oceſter	52	0	*Wincheſter*	51	10
reford	52	14	*Leiceſter*	52	40
nmouth	51	51	*Pembrook*	51	46
rmouth	52	45	*Worceſter*	52	20
arwick	52	25	In *Scotland*		
int	53	17	EDENBURG	55	56
lsbury	57	0	*Glaſgow*	55	52
rthampton	52	18	St. *John's*	57	44
wcaſtle	54	58	St. *Andrew's*	57	45
incoln	53	15	*Sterling*	57	18
ttingham	53	3	*Berwick*	55	49
ſton	53	2	*Aberdene*	58	40
eſter	53	20	In *Ireland*		
akefield	53	54	DUBLIN	53	11
ventry	52	30	*Kingſale*	51	40
arby	53	6	*Cork*	51	47
dford	52	18	*Wexford*	52	18
untingdon	52	99	*Waterford*	52	22
rmarthen	52	2	*Limerick*	52	30
ull	53	50	*Tredagh*	53	38
ſwich	52	08	*King's Town*	53	08
. David's	52	00	*Queed's Town*	52	52

Reflex Dialling.

CHAP. XXV.

REflection ii be made by a piece of *Looking* *Glaſs*, which is ſo much the better, b how much it is thinner; for the thickneſs of i cauſeth a double ray of *Light* to be reflected, an requires a greater Elevation of the *Sun's Beam* than a thin one doth: It muſt be about ſeve times the thickneſs in breadth; and becauſe *Glaſ* reflects from upper and nearer *Superficies*, and ſ makes two *Spots*, colour the lower *Superficie* thereof with *Oyl Colour*, and it will make but on *Spot*.

How to make a Dial *upon the* Cieling *of* Room, *that is parallel to a piece of* Glaſs *placed exactly* Horizontal.

FIrſt, Determine the moſt convenient *Poin* in the *Window* where to place the *Reflecting-Glaſs*, as near the *Ceiling* as you can conveniently, provided it be not ſo near as that th *Corniſh* of the *Window* will ſhadow the *Glaſ* when the *Sun* is high in Summer, ſuppoſe within 10 or a 11 Inches of the *Cieling*; then find Point upon the *Cieling* directly over yout *Glaſs* thus: Hold a Line and Plummet to the *Cielin* juſt over it, and the place where the Plumlin toucheth the *Cieling* is the Point; then through

thi

his Point draw a *Perpendicular* to your *Win-ow:* Now if your *Window* be exactly *South*, his *Perpendicular* upon the *Cieling* will be a *Meridian - Line*; but if your *Window* declines he true *Meridian - Line* will make an Angle with this *Perpendicular*, equal to the quantity of ts *Declination*. Therefore having found the *Declination* of your *Window*, take 60 deg. of Chords, and ſetting one foot in the Point on the *Cieling*, with the other deſcribe a Circle, and ſet thereon (from your *Perpendicular*) the *Declination* of your *Window*, toward your Right-Hand if *Weſt*, but toward your Left-Hand if *Eaſt*; then draw a Line from the point on which you deſcribe your Circle, which Line ſhall be your *Meridian-line*.

2. Draw an *Horizontal - Dial* upon the back of ſome Table, or ſome Plaiſter-wall, or Floor.

3, Take the diſtance between the *Glaſs* and the *Cieling* with your Compaſſes; then come to your *Dial* on the *Wall*, and lay one ſide of your Square to the *Meridian - Line*, and the other croſſing the *Stile*; then move the Square upon the *Meridian-Line*, till the extent of the Compaſſes does exactly touch both *Stile* and *Meridian-Line*, and that point of the *Stile* which does touch the Square, may be called the *Glaſs-point*, from which erect a *Perpendicular*, and where it cuts the *Meridian-Line* make a point, which will be the *Equinoctial-Point*, from which alſo erect a *Perpendicular*, which will be a *Tangent*; then at ſome diſtance on which ſide of the *Equinoctial-Point* you find moſt convenient, erect another *Tangent*; theſe two *Tangent* will cut the *Hour-Lines* in the Points, whic may be called the *Hour-Points*.

4. Take the Diſtance between the *Glaſs-Poin* and *Equinoctial-Point*, and extend it from th *Glaſs* to the *Meridian-Line* on the *Cieling*, an where it toucheth, that is the *Equinoctial-Poin* upon the *Cieling*.

5. Set off correſpondent *Tangent-Lines* upo the *Cieling*, and making like *Hour-Points*, throug thoſe Points draw the *Hour-Lines*.

6. This *Dial* is nothing but an *Horizonta* *Dial* inverted, the Centre being in the Air, except you make a *North Dial*, (which is ſeldom done) then it will be upon the *Cieling*, which you may find by its diſtance from the *Equinoctia* *Point*; then upon that Centre deſcribe a Circle, and likewiſe out of that Centre erect a Perpendicular to the *Meridian Line*, for the *Hour Line* of 6; and you have no more to do but to ſet off from the *Hour Line* of 12, all the other *Hours* according to their ſpaces, in an *Horizontal* *Dial*.

Laſtly, Let your *Dial* on the Wall, remain to take Diſtances for uſes at any other time.

Cylindrical Dialling,

Either

Concave or *Convex.*

CHAP. XXVI.

Of thoſe that fall in a Right Sphere, viz. *ſuch as lie Parallel to the Axis of the* World, *and their* Baſes *Parallel to the Equinoctial.*

HOur-lines may be drawn upon thoſe *Cylinders*, with great eaſe and exactneſs, although in them there may be various Poſitions of the *Axis*.

Sect. I. If the *Axis* fall in the very Centre of the Baſe of the Cylinder, then divide the Circumference of the Baſe of the Cylinder, in 24 equal parts, and draw Lines from the Centre to each of thoſe Points, which will be the Hour-lines for the Baſe of the Cylinder: And where thoſe Lines cut the Circumference Lines, drawn from them down the Cylinder's ſide, they ſhall be the true Hour lines, which will be Parallel each to one another.

Sect. II. If the Point of the *Axis*, fall not juſt in the Centre of the Baſe, of the Cylinder, thro' that Point where the *Axis* falls, and the Centre of the Cylinder draw a Line, and with a pair of Compaſſes take the neareſt diſtance from the *Axis point* and deſcribe a Circle, which divide into 24 equal parts. (beginning at the Diameter firſt drawn) Lines drawn from the *Axis Point*, through every one, of them, and extend to the Side or Circumference of the Baſe of the Cylinder, ſhall be *Hour-lines*, again Lines drawn from them down the Side of the Cylinder ſhall be Hour-lines alſo.

Sect. III. If the Point of the *Axis* fall in any part of the *Periferie* of the Cylinder's Baſe. Then divide the *Circumference* of the Cylinder's Baſe, into 12 equal parts, beginning at the *Axis Point*; Lines drawn from thence to the ſeveral Points, in the *Periferie* of the Circle, and alſo down the Cylinder's Side, they ſhall be the Hour Lines.

Sect. IV. If the *Axis Point* fall without the Baſe of the *Cylinder*. Then the diſtance between that Point, and the neareſt part of the *Periferie*, of the Cylinder's Baſe, being made *Radius*, and a Circle be thereon deſcribed, and divided into 12 equal parts; then Lines drawn from the *Axis Point*, through thoſe Diviſions ſhall each of them cut the *Periferie* of the Cylinder's Baſe, in two Points, from which Lines drawn from one to another (each to this correſpondent) they ſhall be the Hour Lines, and from them Point-lines down the Cylinder's Side, muſt Parallel Lines be drawn. Alſo,

p. ~~103~~ 145

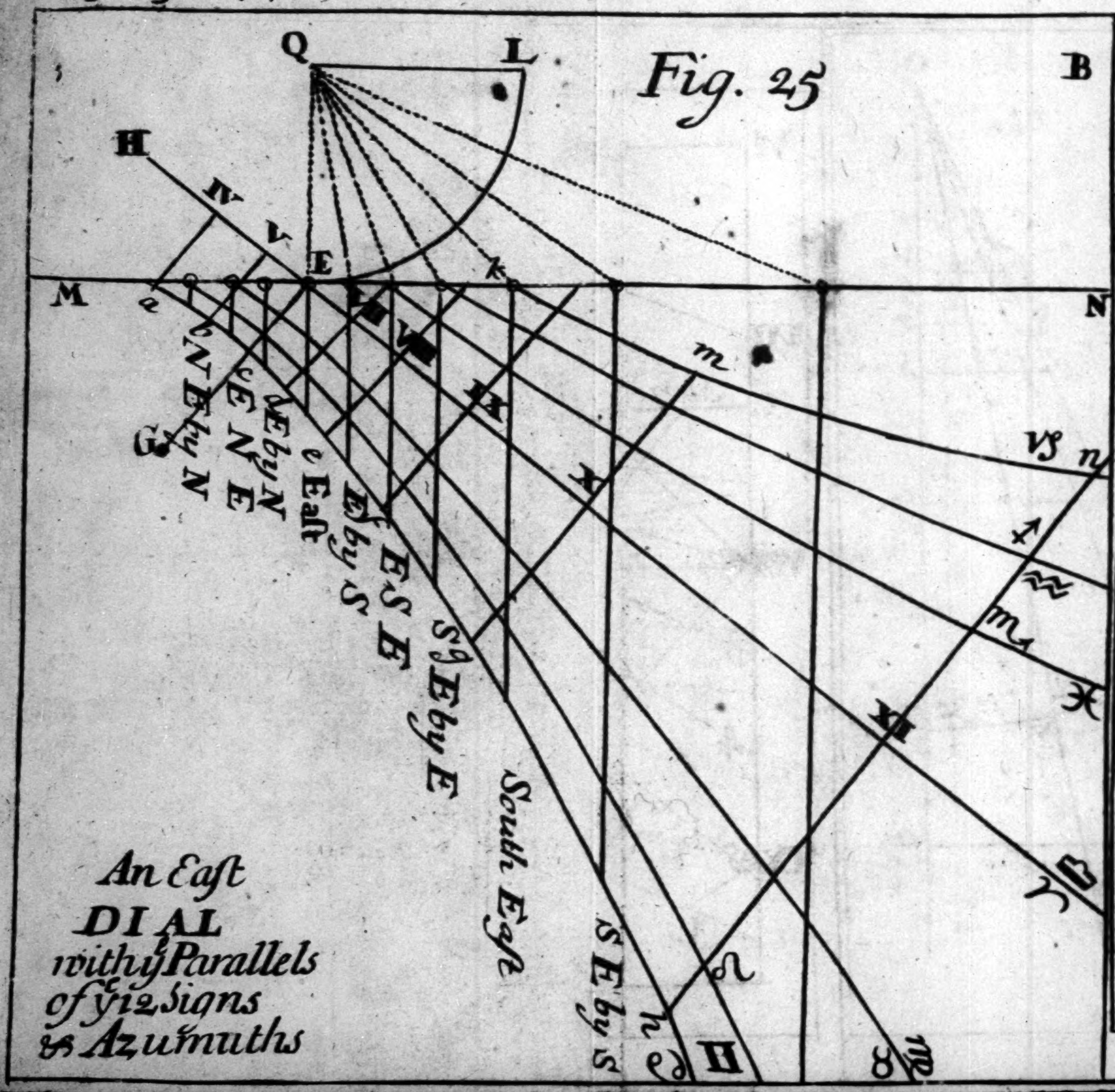
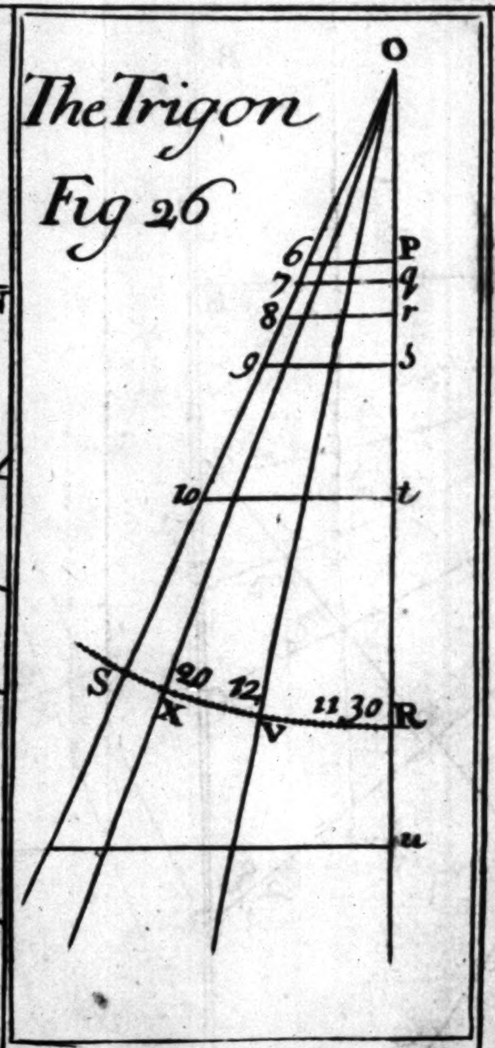


Fig. 25

An East DIAL with ye Parallels of ye 12 Signs & Azimuths



The Trigon

Fig 26

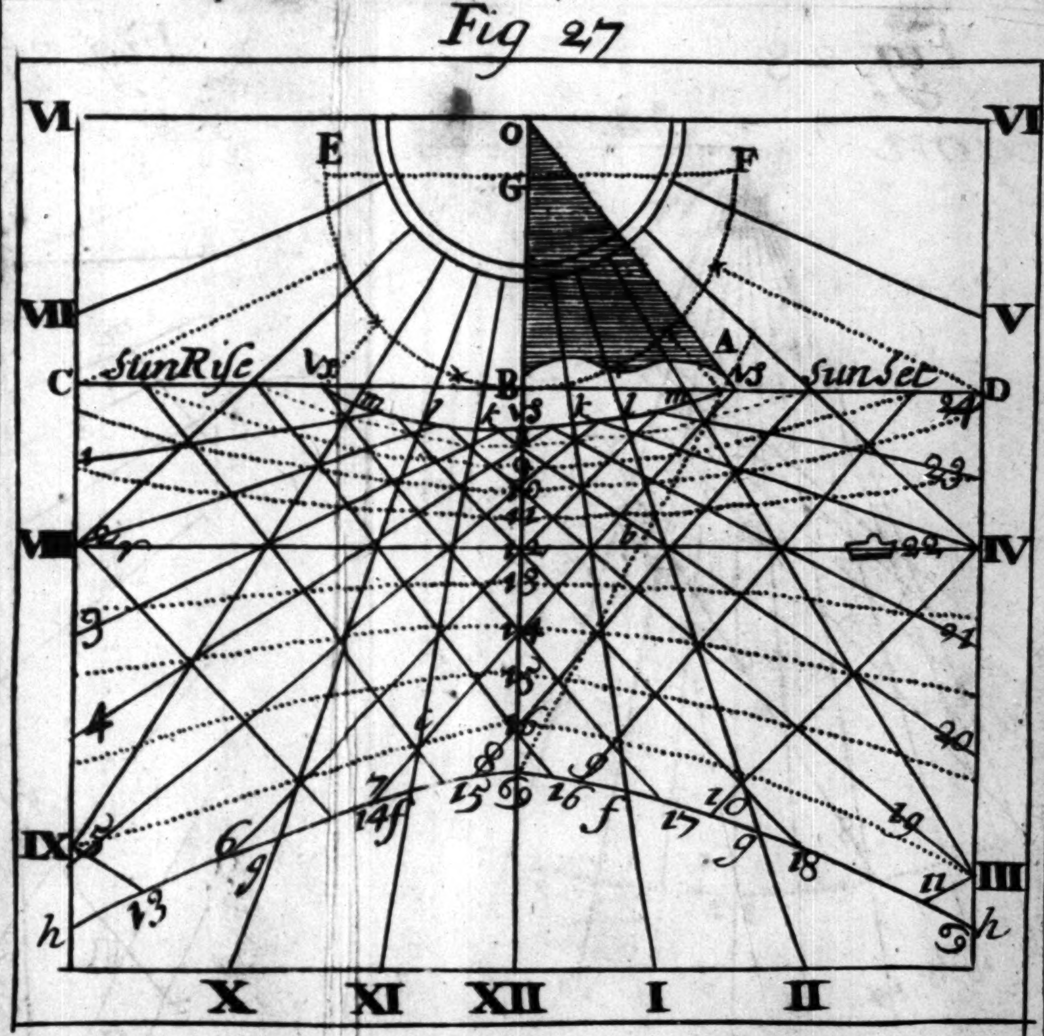


Fig 27

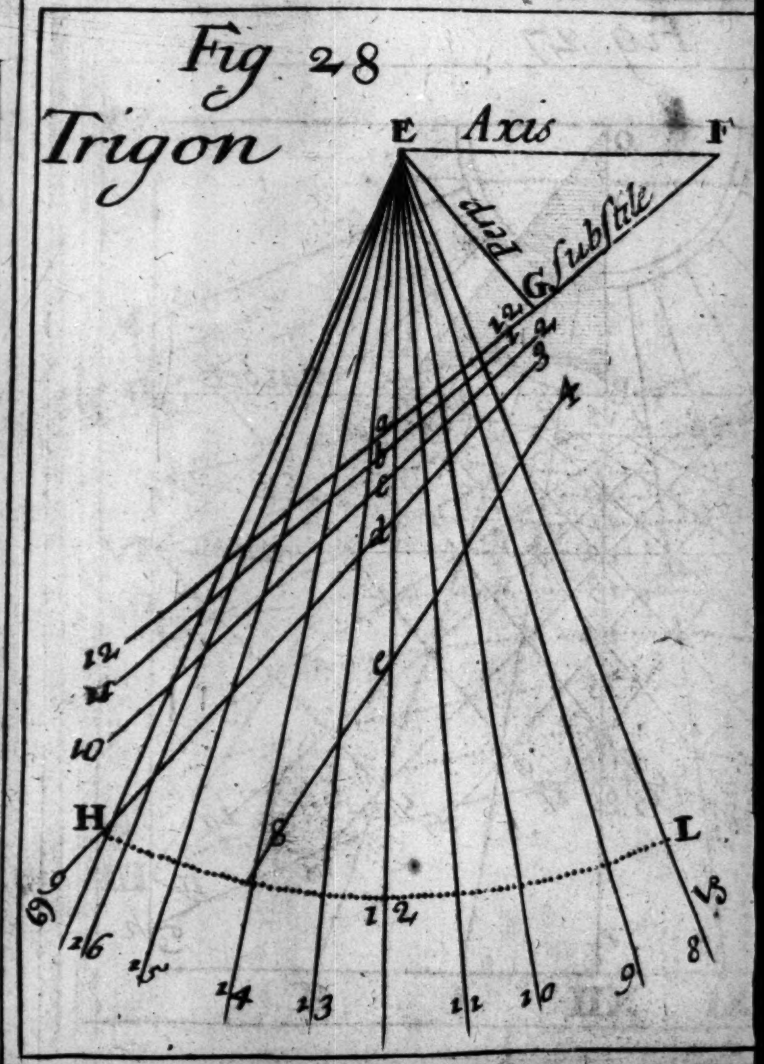


Fig 28

Trigon

Of the Furniture *with which* Sun - Dials *May be* BEAUTIFIED;

And

How to deſcribe ſuch Furniture upon all Sorts of Upright, Direct and Declining Dials, Geometrically.

CHAP. XXVII.

Of ſuch Circles of the Sphere, as are deſcribed upon Sun - Dials.

MAny Aſtronomical Concluſions, may be performed by deſcribing of the *Circles* of the Sphere upon *Sun-Dials*: Of which I have made choice of theſe following.

1. The Parallels of the Signs, ſhewing in what part of the *Zodiack* the *Sun* is, at all times of the Year.

2. The *Diurnal Arches*, ſhewing the length of the Day throughout the Year.

3. The *Hours* from the Sun's Riſing or Setting, or otherways called the *Babyloniſh* and *Italian* Hours.

4. The *Jewiſh* Unequal, or P*lenetary* Hours.

5. The *Azimuths*, ſhewing in what quarter of the World, or upon what Point of the *Compaſs* the *Sun*'s on at all times of the Day.

CHAP. XXVIII.

How to deſcribe the Equinoctial, *the two* Tropicks, *and other Parallels of Declination, upon any* Sun-Dial.

THE two *Tropicks*, being the Boundaries of the Sun's *Courſe* (for he never exceeds thoſe Limits,) therefore it is beſt, *firſt* to ſhew how they may be deſcribed; for between them all other *Circles* (either Great or Small) muſt be Projected, and the manner of deſcribing them upon ſeveral Planes is various.

SECT. I.

On the direct Eaſt, *or* Weſt, *and* Equinoctial Dials.

LET an *Example* be of direct *Eaſt* Dials in the *Latitude* of 51 deg. 30 min.

How to deſcribe the Hour Lines upon theſe Planes, is ſhewed in the *4th* and *7th* Chapters of this Book. Therefore ſuch a *Dial* being drawn as in *Figure* 25, through the Foot of the *Perpendicular Stile*, as at E, draw a Line MEN, Parallel to the *Horizon*; for the *Horizontal Line* in all Planes, muſt be drawn through the Foot of the *Perpendicular Stile*, and alſo through the

Point where the Equinoctial Circle croſſeth the Hour-Line of *Six*. Your Dial, with the Equinoctial Line hereof, HES, being drawn, we come to deſcribe the *Tropicks.*

1. Upon a piece of fine Card-paſt board, draw the Line OR, as in *Figure 26*, repreſenting the Equinoctial Line in your *Dial*; and (becauſe the *Tropicks* are 23 deg. 30 min. diſtant from the Equinoctial) with 60 deg. of your Line of Chords, upon the Point O, deſcribe an Arch of a *Circle*, and ſet upon it 23 deg. 30 min. from R to S, and draw the Line OS, repreſenting the two *Tropicks*; and the Angle SOR, you may call a *Trigon.*

2. Out of your Dial take the length of the *Perpendicular Stile* EG, and ſet it upon your *Trigon* from O to P, and draw the Line P 6 *Perpendicular* to OR. Alſo,

Take the diſtance from G, to the Interſection of the Hour Line of	7 8 9 10 11	*with the Equinoctial, and ſet it upon the* Trigon, *from* O, *to*	*q* *r* *s* *t* *v*	*and draw the Lines*	*q* 7 *r* 8 *s* 9 *t* 10 *v* 11	*perpendicular to* OR.

Thus having prepared the *Trigon*, out of it take the diſtance P *6*, and ſet it upon the *6* a Clock *Hour* line, from E to *c*: Alſo take the diſtance *q* 7, and ſet it upon your Dial from V to *b*, and from VII to *d*: Alſo take *r* 8, and ſet it upon your Dial from IV to *a*, and from VIII to *e*: Likewiſe take the diſtance *s* 9, and ſet it on your Dial from IX to *f*: Alſo, take *s* 10, and ſet it on your Dial from X to *g*; Laſtly, take *v* 11, and ſet it on your Dial from XI to *h*.

Theſe *Points a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, are the *Points* through which the *Tropick* of *Cancer* muſt be deſcribed; therefore if through them a Line be drawn with an even hand making no Angles, that ſhall be *Tropick* of *Cancer*.

The *Tropick* of *Capricorn* may be deſcribed in the ſame manner, for if from your *Trigon* you take

The diſtance	*r*	8	And ſet it upon your *Dial* from	VIII	*k*
	s	9		IX	*l*
	t	10		X	*m*
	v	11		XI	*n*

Thoſe ſhall be the *Points* through which the *Tropick* of *Capricorn* muſt be deſcribed; therefore if through *k*, *l*, *m*, *n*, a Line be drawn with an even *Hand*, it ſhall be the *Tropick* of *Capricorn*: And,

When the Sun is in	*Capricorn*,	which is about	*Decem.*	11	the Shadow of the top of the *Stile* will paſs along thoſe reſpective Lines.
	Aries,		*March*,	10	
	Libra, or		*Sept.*	12	
	Cancer,		*June*,	11	

And according to this Method, may any other intermeditate Parallels of *Declination* be inſerted; as for Example: Suppoſe I would inſert the Parallels of the *Sun*'s entrance into the 12 Signs, *Aries* and *Libra* are inſerted already, alſo *Cancer* and *Capricorn*; for the reſt, as when the *Sun* enters into

Taurus, *Virgo*, *Scorpio*, *Piſces*, } the *Sun* hath 11 deg. 30 min. } of Declinations.
Gimini, *Leo*, *Sagittarius*, *Aquarius*, } the *Sun* hath 20 deg. 12 min. } of Declinations.

Therefore take 11 deg. 30 min. and 20 deg. 12 min. out of your Line Chords, and ſet them upon the Arch R S of your *Trigon*, from R to V and X, and draw the two Lines O V and O X.

Theſe Parallels, being thus put into your *Trigon*, they may be transferred into the Dial, in all reſpects as the *Tropicks* were; and as you ſee done in the *Figure* 26.

SECT. II.

In a direct South *or* North Dial, *Fig.* 27.

HAving drawn your Dial, as is taught in *Chapters* 2, 3, or together with the Stile, your firſt work muſt be to proportion your Stile to your Dial; which to do, aſſume any convenient Point in the Subſtile (here the Line of XII) for the farthermoſt *Tropick*, as here the Point ♋; then the Stile's height being 38 deg. 30 min. add 23 deg. 30 min. thereto, the Sum is 62 deg. and that is the *Meridian Altitude* of the Sun when he enters *Cancer*, and the

the Complement thereof to 90 deg. is 28 deg. Therefore, upon the Point *Cancer*, make an Angle B ♋ A, to contain 28 deg. ſo ſhall the Line ♋ A cut the *Axis* of the Stile O A, in A; then from A let fall a *Perpendicular* to O ♋, as A B; and ſo is your Stile proportioned to your Dial; and the Line C B D (being drawn Parallel to the *Horizon*, through the Point B) ſhall be the *Horizontal-Line* of your Dial.

This done, prepare a *Trigon*, as *Figure* 28, in which make E F equal to O A, and F G equal to O B, and *E* G, to A B, the *Triangle E F G*, in the *Trigon*, equal to the *Traingle* of the Stile O A B, in the Dial.

From the Point *E*, draw a Perpendicular to *E F*, as *E* 12, for the *Equinoctial*; and upon *E*, with 60 deg. of Chords deſcribe the Arch *H* 12 L, and upon it ſet 23 deg. 30 min. from 12 to *H* and *L*, and draw the Line *E H* for the *Tropick* of *Cancer*, and *E* L for the *Tropick* of *Capricorn*: Draw the Subſtiler Line F *G*, quite through the *Trigon*, croſſing the *Equinoctial* in *a*, and both the *Tropicks*.

This done, out of your *Trigon* take the diſtance from *F* to *a*, and ſet on your Dial from the *Center* O to *c*, through which Point draw the Line ♈ *c* ♎ for the *Equinoctial*: Then from O, the *Centre* of your Dial, take the diſtance to the Interſection of the *Hour Line* of 11, or 1 with the *Equinoctial*, and ſet it on the *Trigon*, from F to *b*: Alſo take the diſtance from *O*, to the Interſection of the *Hour Line* of 10 or 2, and ſet it from F to *c*: Likewiſe take the diſtance from O, to the Interſection of the *Hour Line* of 9 or

3,

3, and ſet it from F to *d*: Laſtly, the diſtance from O, to the Interſection of 8 or 4, with the *Equinoctial*, ſet from F to *e*; and draw the Lines, F *a*, F *b*, F *c*, F *d*, F *e*, through the *Trigon*, making them 12, 11, 10, 9, 8, and 1, 2, 3, 4, *&c.* Now to find the Points upon the Dial, through which the *Tropicks* muſt paſs;

The Diſtance from F to	12	will reach from O, the *Center* of the *Dial* to	♋	on the *Hour Lines* of	12	
	11		*f*		11	1
	10		*g*		10	2
	9		*h*		9	3
	8					

Through which Points the *Tropick* of *Cancer* muſt be drawn with an even Hand: And,

The Diſtance from F to	12	will reach from O, the *Center* of the *Dial* to	♑	upon the *Hour Lines* of	12	12
	1		*k*		11	1
	2		*l*		10	2
	3		*m*		9	3
	4		♑		8	4

Through which Points the *Tropick* of *Capricorn* muſt be drawn. And thus you have the *Equinoctial*, and the two *Tropicks*, deſcribed upon a *Direct South Dial.*

SECT. III.

How to deſcribe the Equinoctial, and the two Tropicks, *on any Upright* Dial *Declining, or in ſuch as both* Recline *and* Decline.

AN Example of an Upright *Dial* declining from the *South Weſtward* 30 deg. The making of theſe *Dials* is Taught in the 5*th* and 8*th* or 26*th* Chapters of this Book: Therefore having drawn ſuch a Dial, and the Stile and Subſtile in a due Poſition, you will find the height of the Stile to be 32 deg. 37 min. Firſt, make an Horizontal Dial for the Latitude of 32 deg. 37 min. as in the Declining Dial, *Figure* 29, where the Subſtiler *L*ine is taken for the Hour-line of 12, as it is there marked, and the other Pricked-lines, are the Hour-lines of an Horizontal Dial for the Latitude of 32 deg. 37 min. Now, if according to the directions of the foregoing *Sections* you make *Trigon*, and inſert the *Equinoctial*, and *Tropicks*; and afterwards expunge the obſcure Lines of the *Horizontal Dial*, the *Equinoctial Tropicks*, and Horizontal Line will be the ſame, as if they had been inſerted from the true *Hour Lines* belonging to the *Dial Plane*.

And as the *Tropicks* were deſcribed, ſo likewiſe may the Parallel of the Sun's Entrance into the other Signs, be inſerted if into your *Trigon*, you put there *Arches* of Declinations from the Equinoctial, Namely, 11 deg. 30 min. and

0 deg. 12. min. And ſo are the Parallels of the Signs put into the Dial, *Figure* 29.

And in any Dial, alſo may the Diurnal Arches be deſcribed, if you put into the *Trigon* ſuch Declinations, as the Sun hath from the Equinoctial, when the Days is either,

♑		♋		deg.	min.
				23	30
8		16		21	40
9		15	Hours	16	55
10	or	14	long, as	11	37
11		13		5	55
12		12		0	0

So are the Diurnal Arches put into the *South* Dial repreſented by the Pricked-Lines there, in *Figure* 27, and the *Trigon* thereunto belonging is *Figure* 28.

C H A P. XXIX.

How the Hours from the Sun's-Riſing *and* Setting, *are to be deſceibed into all ſorts of* Sun Dials.

THE *Hours* from *Sun-Riſing*, are called the *Babyloniſh Hours*, for they begin their Day at the *Sun's Riſing*: and the *Hours* from *Sun-Setting*, are called the *Italian* Hours, for in *Italy* they account their Time from the *Setting* of the *Sun* the Day preceding.

The manner how to deſcribe the *Hours* (is th ſame in all *Planes*, and) is eaſily performed And becauſe that upon a full *South*, or *Horizontal Dial*, they will appear moſt Uniform; I hav therefore made choice of a direct *South Dial*, a in *Figure* 27. to deſcribe them: Your *Dial* bein drawn, and the *Equinoctial* ♈ ♎, the two *Tropicks* ♋ ♋, ank ♑ ♑, and the Horizontal-line *Sun-Riſe* ——— *Sun-Set*; you muſt (by the laſ Chapter) deſcribe two obſcure Parallels of Declination, one when the Day is 8 Hours long, a ☺ 8 ☺, and the other when the Day is Sixteen Hours long, as ∗ *16* ∗, the *Equinoctial* being the Parallel when the Day is Twelve Hours long.

Being thus far prepared, te Inſcription of theſe Hours will be very eaſy; for it it is plain, that when the Day is but 8 Hours long, that the *Sun* Riſes at Eight in the Morning; and the firſt Line after the *Sun*'s Riſing is Nine in the Morning; alſo when the Day is 12 Hours long, the *Sun* Riſes at *6* in the Morning, and the firſt *Hour* after, is 7 in the Morning; Laſtly, when the Day is 16 *Hours* long, the *Sun* Riſes at Four in the Morning, and the next *Hour* after is Five in the Morning: And all the reſt as in this Table. Therefore, a ſtreight Line drawn through the Interſection ot theſe *Hours* Lines, with the Parallels of 8, 12 and 16 *Hours*, ſhall be the Firſt *Hour* after the *Sun*'s Riſing all the Year long.

	Length of Days		
Hours from Sun riſing	viii	xii	xvi
i	9	7	5
ii	10	8	6
iii	11	9	7
iv	12	10	8
v	1	11	9
vi	2	12	10
vii	3	1	11
viii	4	2	12
ix	5	3	1
x	6	4	2
xi	7	5	3

In the like manner, if you would inſert the ſeventh after the *Sun*'s *Riſing*: By the Table you ſee, that the Parallel of viii Hours, for the length of the Day, the ſeventh Hour from *Sun* Riſing is 3 in the Afternoon; therefore obſerve where the Hour-line of 3 croſſeth the Parallel of viii Hours, which is at *a*. Alſo by the Table you ſee that in the Parallel of xii Hours, for the length of the Day, the ſeventh Hour from *Sun-Riſing*, is 1 in the Afternoon; therefore obſerve where the *Hour-line* of 1 croſſeth the *Equinoctial*, which is at *b*. Thirdly, by the Table you ſee, that in the Parallel of xvi *hours*, for the length of the Day, the ſeventh *hour* from the *Sun*'s Riſing is 11 in the Forenoon; and therefore obſerve where the Hour-line of xi croſſeth the Parallel of xvi *hours* for the length of the Day, which at *c*; ſo ſhall a right-line drawn through theſe Points, *a*, *b*, *c*, be the ſeventh *hour* after the *Sun*'s Riſing throughout the Year: And thus by the help of this Table, you may draw all the Hour-lines from the *Sun*'s Riſing, as you ſee them drawn, and numbred as in *Figure* 27.

In the ſame manner, as the *Hours* from the *Snn*'s Riſing (which are the *Babyloniſh* hours) were drawn, may the Hours from the *Sun*'s Setting

(which are the *Italian* Hours) be drawn : The difference being only in the numbring of them ; the hours from *Sun* Riſing, being numbred from the *Weſt* end of the *Horizontal-line*, by 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 : And the *Houre* from *Sun-Setting*, from the *Eaſt* end of the *Horizontal-line* backwards, by 23, 22, 21, 20, 19, 18, 17, 16, 13 ; as appears in *Figure* 27.

A Corollary ariſing from the Work of this Chapter.

The Hour-lines from *Sun* Riſing and *Setting*, being deſcribed upon any *Dial*, as is before taught, there will by their correſpondent interſections one with another, be Points produced through which if *Lines* be drawn, with an even hand, the ſame ſhall be the *Parallels*, of the length of the Day, and ſuch are pricked Lines in *Figures* 27, numbred upon the *Meridian-Line* of the Dial, by 8, 9, 10, 11, 12, 13, 14, 15, 16.

CHAP. XXX.

Of the Jewiſh, or Old Unequal, or Planitary hours, and how they may be deſcribed upon any Sun-Dial.

THE Ancients, account their Day, was from the *Sun's* Riſing in the *Morning*, till it's *Setting* in the *Evening*, which ſpace of time they did divide into Twelve equal Parts, were it long, or ſhort ; ſo that in the *Summer*, all the Time that the *Sun* hath North-Declination, the Hours of their Day, was longer than a Common equal Hour; and in the *Winter* when the *Sun* hath *South* Declination the Hours of their Day were ſhorte than a Common equal *Hour*; but when the *Sun* is in the Equinoctial, their Hours are equal to our common Hours.

The Inſcription of theſe Hour-lines, into all ſorts of *Sun-Dials* is very eaſie, being much like the Inſcription of the *Italian*, and *Babyloniſh* Hours, Taught in the laſt Chaper.

Having drawn your *Dial*, with Hours, halves, and quarters; and alſo the *Equinoctial*, the two *Tropicks*, and Horizontal-line; and alſo the *Parallels* of the length of the Day, as is done in *Figure* 28, which a *South Dial Decliniug Eaſtward* 15 deg. you muſt make choice of two *Parallels* of the length of the Day, which muſt be both of them be equi-diſtant from the *Equinoctial*, which let be the *Parallels* of 9 *Hours*, and 15 *Hours*, for thoſe two *Parallels* are moſt convenient for this purpoſe becauſe the *Jewiſh Hours*, in thoſe *Parallels* will juſtly

The Jewiſh.	*The Parallels of* 15 H.		*Equinoctial.*	*The Parallel of* 9 H.	
H.	H.	M.		H.	M.
i	5	45	7	8	15
ii	7	00	8	9	00
iii	8	15	9	9	45
iv	9	30	10	10	30
v	10	45	11	11	15
vi	12	00	12	12	00
vii	1	15	1	0	45
viii	2	30	2	1	30
ix	3	45	3	2	15
x	5	00	4	3	00
xi	6	15	5	3	45
xii	7	30	6	4	30

juſtly fall upon the even *Hours*, halfs, or quarter Now the Points through which the *Jewiſh* hours are to be drawn, as the Table before will direct wherein you ſee, that the firſt *Jewiſh* hour is to be drawn through 5 hours, 45 min. in the *Parallel* of 15 hours, through 7 in the *Equinoctial*, and through 8 hours and 15 min. in the Parallel of 9 hours: In like manner the ſecond *Jewiſh* hour muſt be drawn through the interſection of 7 hours, in the Parallel of 15 hours, through 8 in the *Equinoctial*; and through 9 in the Parallel of 9 hours: And ſo muſt all the reſt of them be deſcribed as the Tables does direct, and as you ſee done in *Figure* 30. And in this manner, by the help of this Table, may they be deſcribed in all ſorts of *Planes*, whither Direct Reclining, or Declining.

CHAP. XXXI.

How the Azimuth muſt be deſcribed, upon any Sun-Dial.

THE *Azimuths* are great Circles, and being projected npon all Dials, become ſtreight lines; and they are variouſly deſcribed, according as the Dial-Plane is Scituated, particulars of which follow.

SECT.

SECT. I.

On an Horizontal Dial.

IN theſe Dials the *Azimuths* are moſt eaſily deſcribed: For, your Dial being drawn, with he *Tropicks* thereon, you have no more to do, hen upon the foot of the *perpendicular* Stile as t O (in *Figure* 31.) as a *Center*, to deſcribe a *ircle*, as ♋, N♋, which you may divide into 2 equal points (beginning at N) anſwering to he 32 points of the *Mariner's Compaſs*, or elſe ou may divide it into 90 equal parts or degrees, oted with ✳✳✳, *&c.* and through thoſe points raw ſtreight Lines from O, the foot of the *perpendicular* Stile, and they ſhall be the true *Azimuth* upon an Horizontal Dial, which you may denominate by South S, *by* E, S. S.E, S. E. *by* S, *&c.* as you ſee done in *Figure* 31.

SECT. II.

Upon a Direct Eaſt, or Weſt Dial, Fig. 25.

HAving made an Eaſt *Dial* and therein inſerted the *Equinoctial*, and the two *Tropicks*, and the *Horizontal Line*, you may proceed to deſcribe the *Azimuths* in this manner;

Upon the point E, of the Horizontal-Line of your Dial, MEN, erect the *Perpendicular* EQ, equal to EG (the height of your *Stile* of your Dial)

Dial) and upon Q, as a Center, deſcribe the *Quadrant* QEL, and divide it into eight equal parts, repreſenting one quarter of the *Mariner's Compaſs*, and from Q through thoſe Points, draw Lines to the Horizontal Line MEN, as ☼☼☼☼☼ from which points let fall Perpendiculars from the Horizontal Line, and they ſhall be the *Azimuths* between the *South* and the *Eaſt*; and for thoſe Points which fall between the *Eaſt* and the *North*, as E by N.——E.N.E.——N.E. by N.— are the ſame Diſtances ſet upon the Horizontal Line from E, towards the Left hand, as the firſt three *Azimuths* towards your Right hand, is as ☼☼☼; through which Points, if lines be drawn perpendicular to the Horizontal Line, they ſhall be the *Azimuths*, or points of the *Compaſs* between the *Eaſt* and the *North*: As in Fig. 2 And as the Eaſt *Dial* contains the *Azimuths* between the *South* and the *Eaſt*: The *Weſt* Dial muſt contain thoſe between the *South* and the *Weſt*.

SECT. III.

Upon the Direct South upright Dial. *Fig.* 27.

THE Dial with the Equinoctial, and the two *Tropicks* and the Horizontal Line deſcribed thereon, the *Azimuths* may be inſerted thereon as followeth.

Firſt, take the length of the *perpendicular* Stile of your Dial AB, and ſet it upon the *Meridian* of your Dial from B to G.

p 161

Fig 29

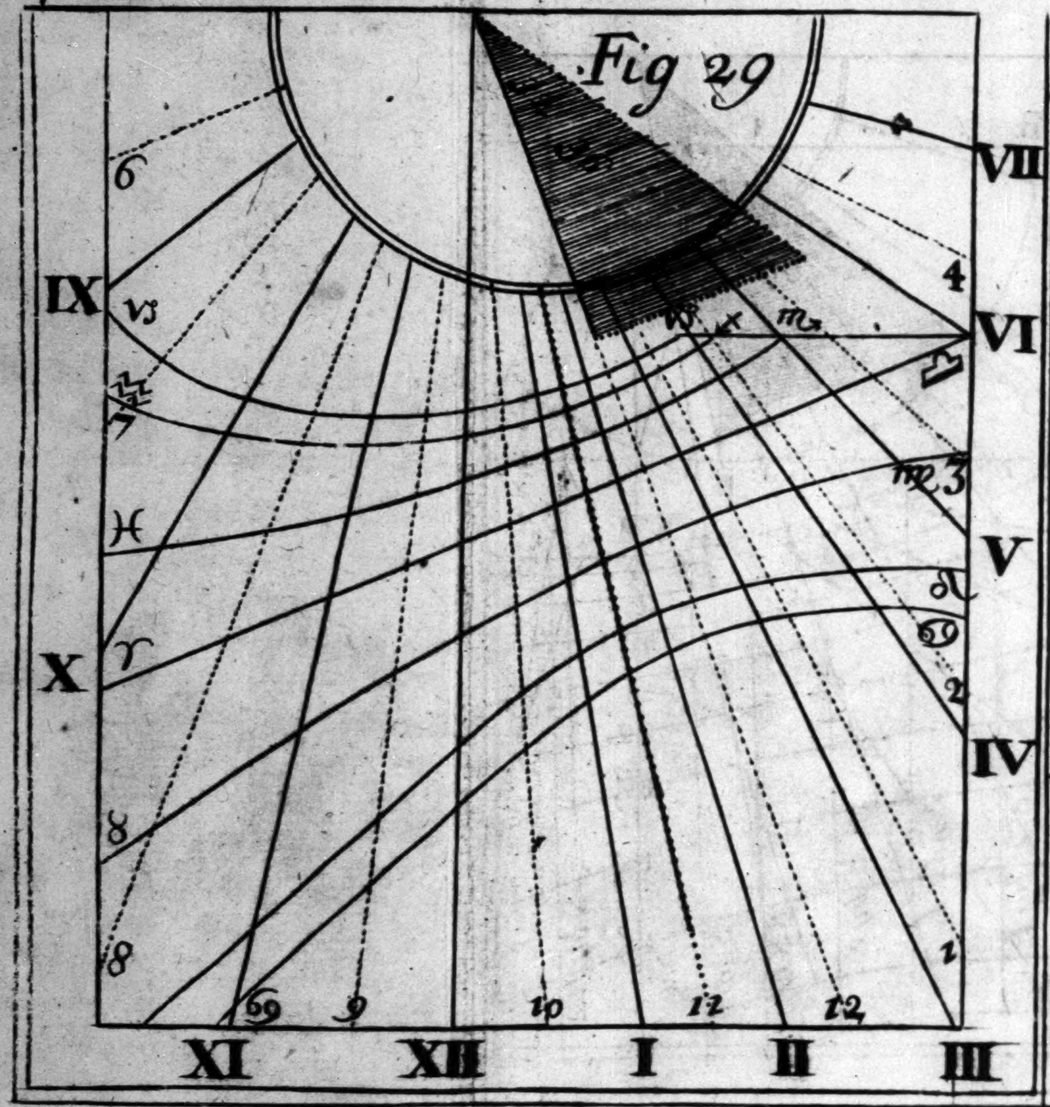


Fig 30

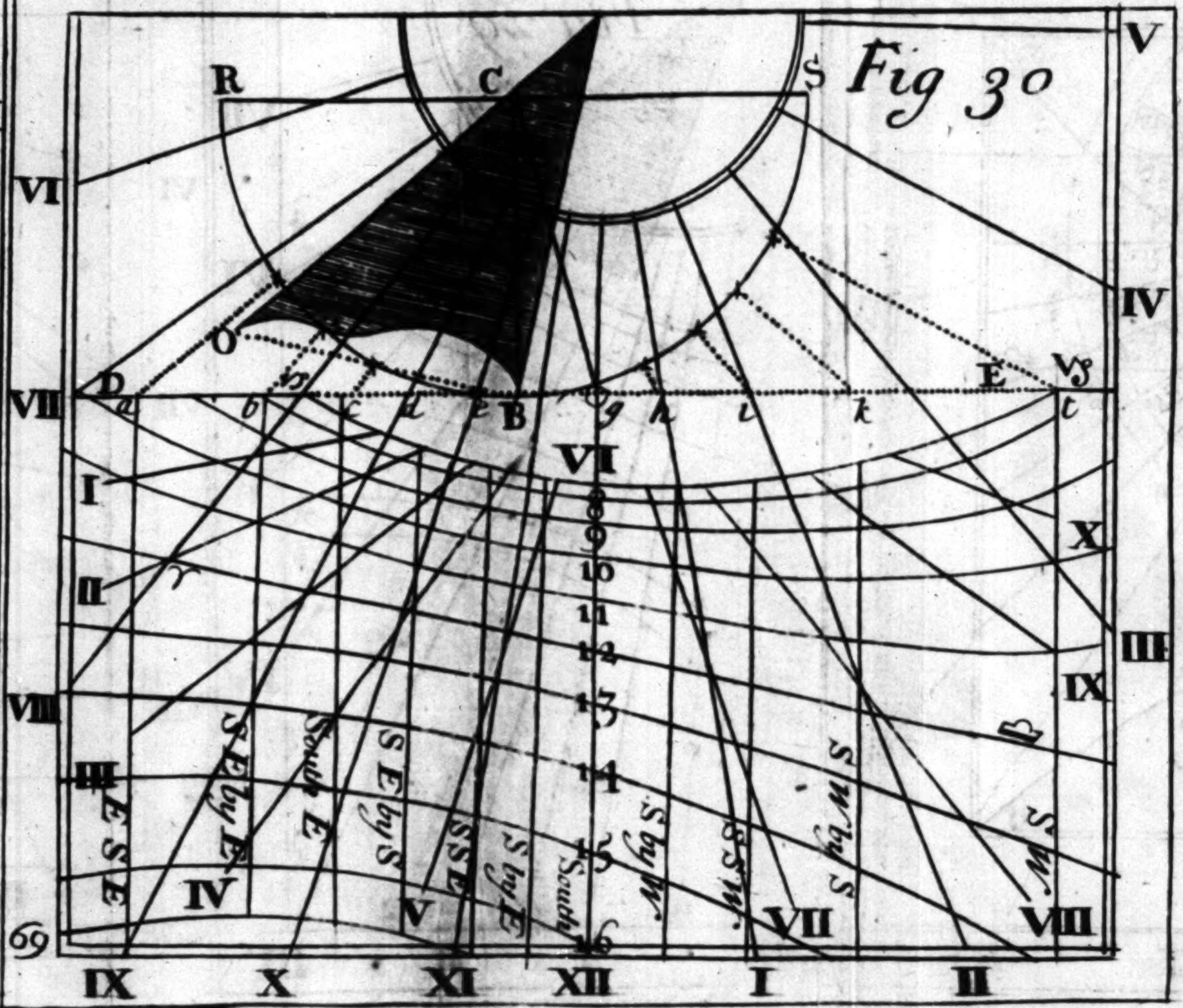
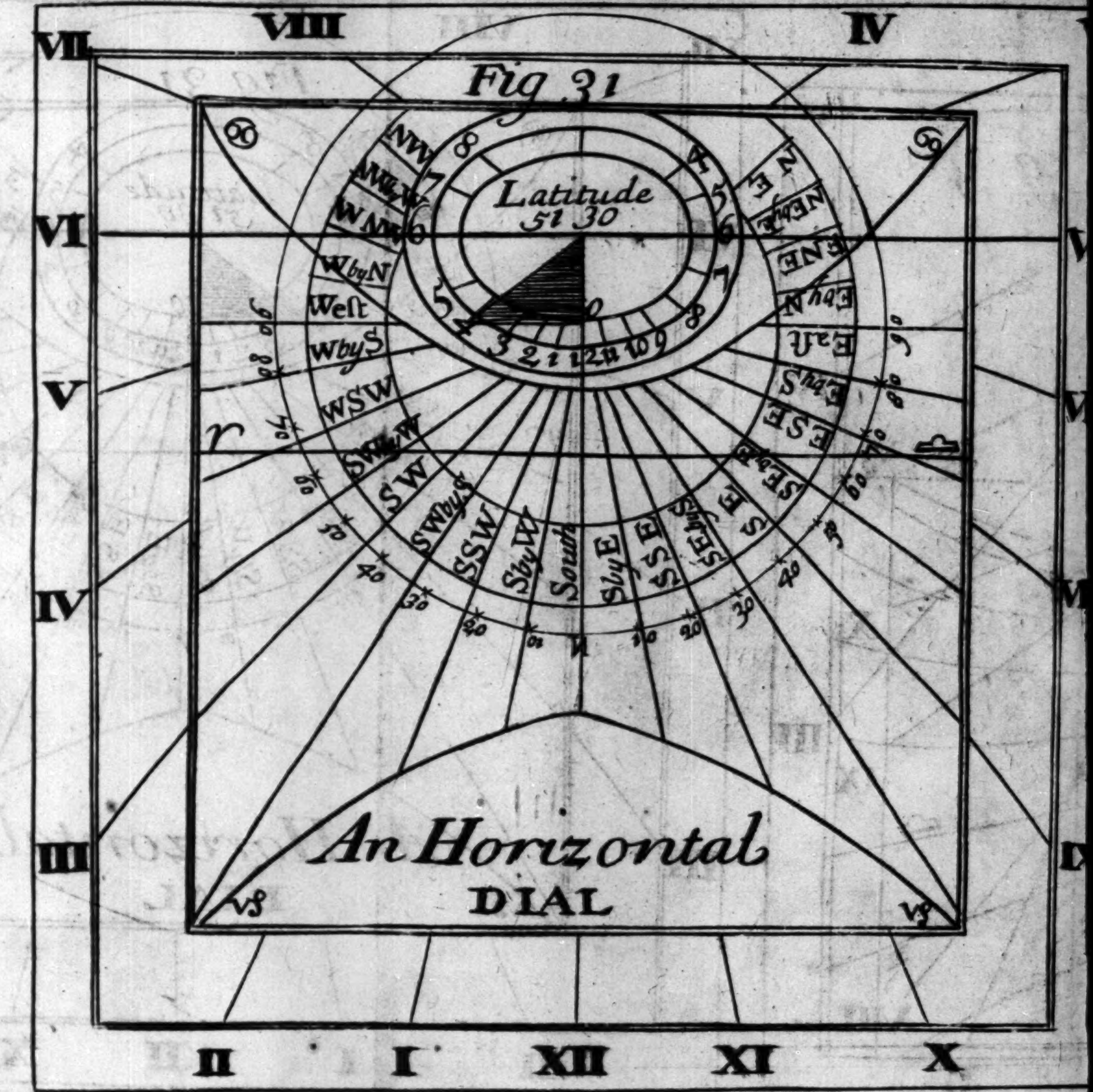


Fig 31



Secondly, With the diſtance GB, upon G, deſcribe the Circle EBF, which divide into 16 equal parts (if you will) but I have here divided it but into 8, to ſhew the manner of the Work, in the Points ✱✱✱✱, *&c.* Through which Points from G, draw obſcure lines extending them till they touch the Horizontal Line of your *Dial* CBD, now if from theſe Points of touching you draw lines perpendicular to the Horizontal Line between the *Tropicks*, (or Parallels to the Line of 12,) they ſhall be the *Azimuth* required.

Note, I have not drawn the lines themſelves in this *Fig.* 27. becauſe the Dial is full enough of *Lines* already.

SECT. IV.

Upon the South Declining Dial. *Fig.* 30.

AN Example ſhall be of a *South* Dial, Declining Eaſtwards 15 deg.

Such a *Dial* being drawn, and the *Equinoctial*, *Tropicks*, and the *Horizintal-Line* inſerted thereon: Upon the Point B of the Horizontal line erect the P*erpendicular* BC, equal to BO, the *Perpendicular Stile* of your *Dial*; upon which Point C, deſcribe the Semicircle RBS, which done, lay a *Ruler* to C, and the Point ☉, where the Hour-line of 12 croſſeth the Horizontal Line, and where the *Ruler* cuts the Semicircle RBS, at that *Point* begin to divide it into 16 equal parts, at the Points ✱✱✱, *&c.* And from the Center C, draw lines obſcurly through thoſe Points, ex-

tending

tending them till they touch the Horizontal Line, DE, in the Points *a b c d e ſ g h i k* and *l*, through theſe Points Right lines being drawn, *Parallel* to the *Meridian*, ſhall be the *Azimuth* deſired; which you muſt number according to the *Scituation* of the *Plane*: Namely the Weſtern *Azimuths* on the *Eaſt* ſide of the *Meridian*, and the *Eaſt Azimuths* on the *Weſt* ſide of the *Meridian*, as you may ſee in *Figure* 30.

CHAP. XXXII.

Of the Meridians of other Countries, and how to inſert them into any Sun-Dial.

IT is eaſie to inſert the *Meridian* of any othe *Country* into any *Sun* Dial, made for any othe Place; if firſt you know the difference of *Longitude*, between the two *Countrys*, in Time; and alſo, whether the Remote *Country* lie *Eaſtwar* or *Weſtward*, from the *Home Country*: For,

If the Remote *Country* lie *Eaſtward* of th Home Country, it is *Noon* ſooner than it is at tha Place the *Dial* doth ſtand in; if it lie *Weſtward*; then it is *Noon* later.

As for Example,

Suppoſe that in a *Sun-Dial* here at *London*, yo would inſert the *Meridian* or *Noon-tide* of *Conſtantinople* by the beſt *Geographers*, the *Meridia* of *Conſtantinople* lies *Eaſtward* of the *Meridia* of *London*, 30 deg. 45 min. which converted int Time by allowing 15 degrees to one hour, and

degre

degree to 4 minutes of Time, it is 2 hours and 15 min. that is 2 hours and a quarter. Wherefore if you ſubtract 2 hours 15 min. from 12 hours, the Remainder will be 9 hours 45 min. or 3 quarters of an hour. Therefore if upon a *Dial* here at *London*, you write the word *Conſtantinople*, upon the *Hour-line* of 9 and 3 quarters, [or make this ✳,] the ſhadow of the *Stile* of the *Dial*, when it ſhall fall upon the *Word* or *Mark*, you may conclude it to be *Noon* at *Conſtantinople*; and knowing that, it is eaſily known what hour it is at any time of the Day.

You have ſeveral Countries inſerted in the *Direct South Dial.* Fig. 5.

CHAP. XXXIII.

The manner of Cutting divers Bodies in Wood or Stone, and making Dials upon them.

THere are ſeven Bodies uſually cut in *Stone* or *Wood*, whereof five of them are called Regular Bodies, becauſe they may be Inſcribed in a Sphere: And they are alſo called the five Regular *Platinical* Bodies, becauſe *Plato* was the Inventor of them, and are as followeth, the *Cube*, the *Tetrahedrum*, the *Octohedrum*, the *Dodecahedrum*, and the *Icoſahedrum*, the others are one of Twelve *Rhombs*, and the other of Thirty *Rhombs*: And be- *Cube* is the *Mole* or Lump, out of which the reſt are contrived I ſhall begin with that firſt.

How to Cut the Cube.

[*Definition*] A *Cube*, is a ſolid Body comprehended by Six equal Squares, as are A, B, C, D, A, D, E, F, and D, C, F, G. — The cutting of this Body is plain by the Definition ; for let every ſide of every ſquare be equal, as A, B, to D F, A, E, to C, G, *&c.* and you will make a *Cube* of what greatneſs you will, this Body is capable of five ordinary *Dials*, the ſixt ſquare being the Baſe to ſtand upon : wherefore if you ſet the ſide A, D, E, F, *South*, then will the ſide oppoſite thereto be *North*, D, C, F, G, *Eaſt*, and the ſide oppoſite will be *Weſt*, and A, B, C, D, Horizontal, all which *Dials* are made in the former part of this Book : But if you place any of the Angles of the Horizontal Squares *South*, then will every ſide decline 45 deg. for if you turn the Angle D, *South*, then will the *Diagonal* Line A, C, be *Eaſt* and *Weſt*, and the ſide C, D, F, G, will be a *South* declination, *Eaſt* 45 deg. and his oppoſite a *North* declining *Weſt* 45 deg. and A, D, F, E, is a *South* decl. 45 deg. *Weſt*, and his oppoſite a *North* declining 45 *Eaſt*, all which *Dials* are made by the Direction in this Book.

How to Cut the Tetrahedrum

[*Definition*] The *Tetrahedrum*, is a ſolid Body comprehended by four *Equilateral Triangles*, as A C B, A C D, and D C B.

To Cut this Body, you muſt make a *Parallelpiped.*

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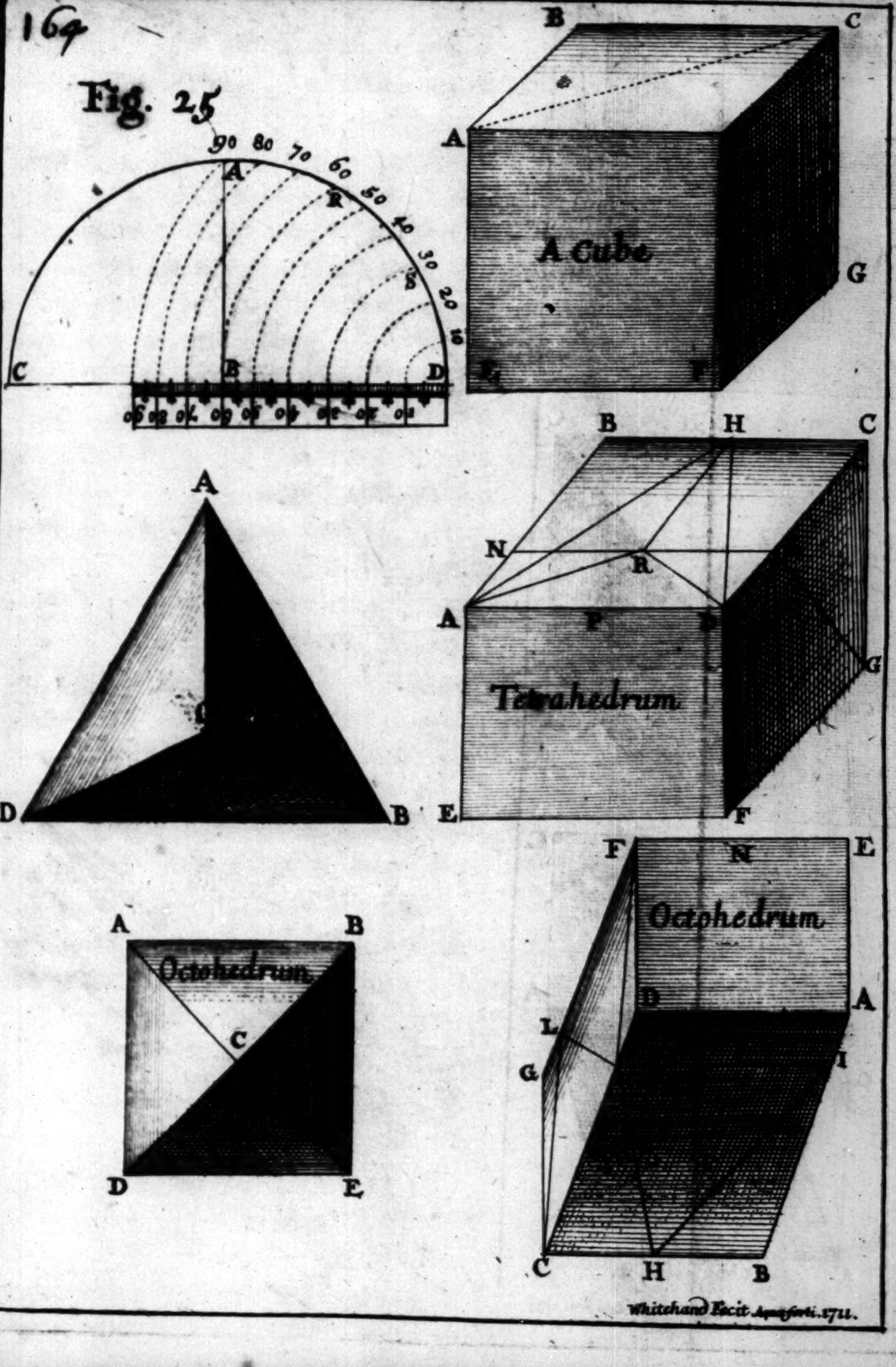
Fig. 25



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piped. Let the Breadth A D, be 10000, and the height A E, be 8164, and the Length A B, be 8660, upon the upper Face and Baſe thereof draw to oppoſite *Equilatral Triangler*, as A D H, divide the Perpendicular P H, into three parts, and ſet one part thereof which is equal to 2886, from A to N, and from D to L, draw the line N L, and in the middle of the point R, will be the Vertex of the Solid A B D; From the Point L to the Angles F and G, draw to ſtreight lines L F, and L G; do the like on the oppoſite ſide by the point N; cut off the two *Triangular* potions L, D, E, N, A, F, and G, L, C, N, B, ſo will their remain the Solid Body called a *Priſma*, whoſe two ſides F L G, and the Oppoſite, are equal *Triangles*, the other three ſides L, F, N, E, &c. are *Paralellograme*. Next by the points F, K, H, and the ſide of the *Triangle* F H, drawn in the Baſe; as alſo by the poines E K H, and the other ſide of the *Triangle* E H, cut this *Priſma*, and their come forth the Solid Body A, C, D, B, the *Tetrahedrum* deſired. The Body thus prepared ſet the Angle A *South*, then will the ſide B O D. be the *North* Reclining 19. 28 and the other two ſides AOB, and AOD, will be *South* decliners 60 deg. and will recline as the former. The making of theſe Dials is Taught in the former part of this Book. The Requiſites and hour diſtances are as followeth.

North Recl. 19.28. *the Complement of the Lat. add* 38.28 *The St. heig.* 57.56

Direct North Reclining.

Hours from the Meridian		*True Hour diſtances*	
Hours		D.	M.
12		00	00
11	1	12	48
10	2	27	04
9	3	40	17
8	4	55	44
7	5	72	28

Hours from the Subſtile.	*True Hour diſtances.*		*Hours from the Subſtile.*
South-	Declin.		Reclin.
	d.	m.	
3	10	36	9
4	04	00	8
5	02	13	7
6	01	18	6
7	00	41	5
8	00	10	4
Subſtile			*Subſtile.*
9	00	19	3
10	00	52	2
11	01	32	1
12	0	37	12
1	0	00	11
2	19	26	10

The other two *South* Reclining Declining have the ſame *Dials* ſerving for both; changing but the Poſition of the Subſtile and hours as hath been directed. The Requiſites of the foregoing Table of *South* Declining Reclining are as followeth.

The Planes Reclination ——— ——— ———19. 28
The Planes Declination *Eaſt* or *Weſt*, ——— 60. 00
The diſtance of the *Mer.* and *Horizon*, ——— 60. 00
The Stiles height above the Plane ——— 01. 50

The *Subſtiles* diſtance from the *Meridian*—02. 36
The Planes Longitude——— —— ——— ——— 34. 46
Therefore the Subſtile falleth between 8 and 9 of the Clock in the *Eaſt* Dial, and between 3 and 4 in the *Weſt*.

The beſt way of making theſe two Dials will be by the Polar Scales as you did the far Decliners.

How to Cut the Octohedrum.

An *Octohedrum* is a ſolid Body, comprehended of eight equal *equilatral Triangles*, as are A C B, A C D, B C E, and E C D; To cut this Body you muſt make a *Parallel-piped* B E F C, let the breadth thereof B C, or A D, be 10000, and the height thereof A E, or C G, be 8164, and the length thereof B A, or F G, be 11547, let A I, and D K, and L C, be 2887, one fourth (or a quarter) of A B, or F G, by which draw the line I *K*, upon the Superficies, and the like by L, in the Baſe, make equilateral Triangles I K H upon the Superficies, and from the point L in the Baſe the like, ſo that the Point N of the Triangle in the Baſe may be oppoſite to the point H, of the Superficies; draw the lines K F, K L, and L C, on the one ſide of the Figure, and the like on the other ſide, cut off the *Triangler* portion I K F E, downwards, and the oppoſite to it *L* G C B, upwards, and there will remain two equal Oblongs K I B H C, and L F N E, the Baſe inclining from the line B *H* C, as much as the Superficids doth recline from the Perpendicular of N E F, next cut off the portions L K H, and I H, above, L K N. and I N, by the *Triangle* beneath, ſo ſhall you have at ſix cuts the ſolid of eight equilateral *Triangles* A B C D E, deſired. The Body thus prepared, ſet the Angle C, of the Horizontal A C B, *South*, and the ſame Dials of the *Tetrahedrum*, will ſerve for the *Octohedrum* alſo; for the Plane B C E, will be a *South* Incliner, and his oppoſite a *North* Reclining 19. 28, and the Plane D A C, and ECB, will decline 60 deg and Recline as the other, and their oppoſites Declines and Inclines, 60 deg. as may be ſeen by Bodies themſelves, joyning the Reclining ſide, B C D, of the *Tetrahedrum* to the Inclining ſide D C E, of the *Octohedrum*, will plainly demonſtrate the ſame, the Dials being the one and the ſame in both, there will not be any need to reiterate the Work over again.

How to CUT

The Dodecahedrum.

THE *Dodecahedrum* is a ſolid Body, comprehended of 12 equilateral Pentangles, as H S R V O. H S B A, and *H* O E S, *&c.* To Cut this Body, you muſt firſt make a Cube; as is P R S V, divide each ſide into halves, as P q. at, a. b. R. S. at f. o, and X. P. at C. D. let each half P. a, X. o, and R. f, be the *Radius*, or 10000 divided by extream and mean Proportion P. g, X. n, and V. o, ſhall be 6180, the greater

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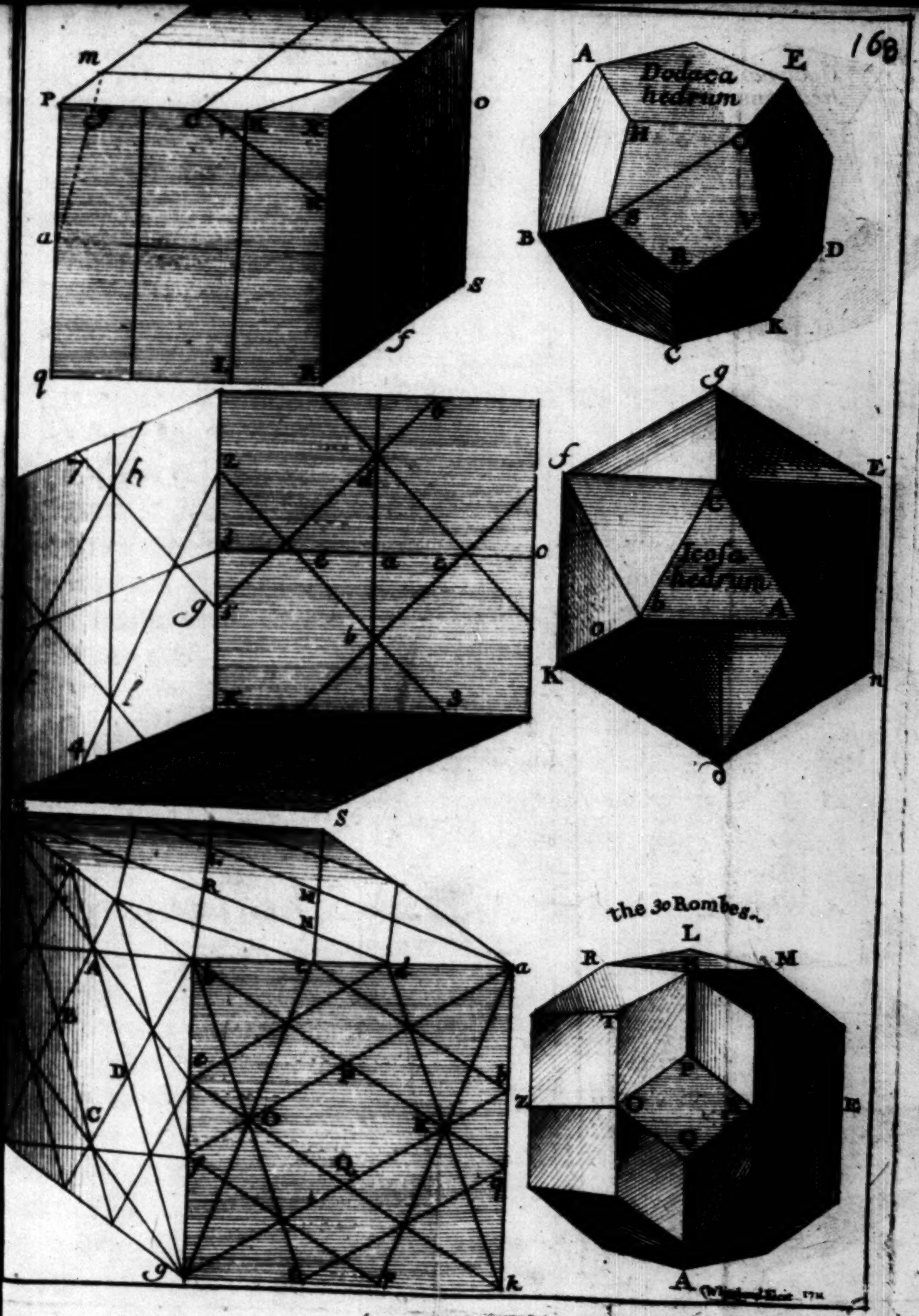


er Segment, and g. c, and n. b, be 3820, the leſſer Segiment, and ſo muſt the reſt of the ſides be alſo divided, but with this Caution, that the middles and ſegments of every ſide Conterminous be drawn croſs to others, as thoſe of P. q, R. X, croſs to thoſe of *X. R*, and S. V, and they again croſs to them of *P. X*, and *V. Z*, yet every oppoſite ſide Parallel to each other, from the greater *Segment* of the one ſide, to the middle Line of the other, draw ſtreight Lines croſs the Body, as are *n.* C, K. *o*, and *o. b*; cut off each Triangular *Priſma*, viz. *n. o*, *D.* C, *L. K*, *f. o*, and *m. o. b. a*; and ſo of the reſt. And ſo ſhall you at twelve Cuts, frame the *Dodecahedrum*, conſiſting of twelve *Pentangles*, as is repreſented by the *Figure*: The Body being thus prepared, ſet the Angle *H*, of the Horizontal Plane *H R S V O*, *South*, then ſhall the five ſuperiour *Planes* recline, and their Oppoſites incline as much, *viz.* R*V D K C*, will be a direct *North* reclining 26 deg. 33 min. and *V O D E*, and R*S B C*, two *North* reclining as much, and declining alſo 72 deg. *H O E A*, and *H S B A*, two *South* reclining as much, and declining 36, the Reclination of the five *Planes* being the ſame.

Having the Reclination of the direct *North* Dial, it is to be made as you have been Taught in the foregoing *Chapters*, whoſe Hour diſtances, for all the *Planes* are as followeth.

Direct North,

Reclining
26 23

Stiles height
65 01

Hours		*d.*	*m.*
12			
11	1	00	09
10	2	13	38
9	3	27	38
8	4	42	12
7	5	57	30
6	6	73	32
		90	

North Reclining 26 33 *Declining* 72 00				*South Reclining* 26 33 *Declining* 36 00			
Hours		*Hours on the Plane.*		*Hours*		*Hours on the Plane.*	
12		82	05	04	08	71	42
1	11	56	22	05	07	18	13
2	10	37	35	05	06	09	07
3	9	24	18	07	05	05	21
4	8	14	12	08	04	03	03
5	7	05	43	09	03	01	02
Sub-		ſtile.		Sub-		ſtile.	
6	6	02	10	10	02	00	11
7	5	10	17	11	01	01	44
8	4	19	30	12		03	34
9	3	31	07	01	11	06	06
10	2	47	09	02	10	10	34
11	1	69	51	03	09	23	15

Note, The *North* Recliners and their Oppoſite declining 72 deg. have the ſame Dials ſerving for all four, changing the Poſition of the *Stile* and *Hours*, as before was directed; and are to be made by the *Rules* of the foregoing *Chapters.* The Requiſites for both the reclining declining *Dials* are as followeth.

Firſt, *For the* North *Dial declining* 72 *deg.*

North Reclining — — —	26.33
Declining *Eaſt* and *Weſt* ———	72 00
The diſtance of Meridian and Horizon	36.00

The

The Subſt. diſtance from the Mer.	82.04
The Plane's difference of Longitude	85.50
The Stiles height	31.28

Secondly, *The Requiſites for the* South *declining 36 deg.*

South Reclining	26.33
Declining *Eaſt* and *Weſt*	36.00
The *Diſtance* of the *Mer.* and *Hor.*	72.00
The *Subſtiles* diſtance from the *Meridian*	03.33
The *Planes* Difference of *Longitude*	31.33
The *Height* of the *Stile*	05.44

How to CUT

The Icoſahedrum.

THE *Icoſahedrum* is a Solid, comprehended of twenty equal *Equilateral* Triangles, as are *A. b. C, A. b. d, A. E. C, C. b. f,* &c. There are two ways to cut this Body; the one is the very ſame as the *Dodecahedrum* was cut, drawing the Parallel Lines upon the Cube, at the diſtance of the leſſer *Segment*, as there you drew them from the greater *Segment*.

The other way is thus; divide each ſide of the Cube *p. q. r. X*, into half, and draw ſtreight Lines croſſing at right Angles, as *b. d, c. e, h. l,* and *f. g*, and *k. m*, and *l. n*; then making *p. o*, or *o. a*, half the ſide, the *Radius* 10000, let *a. c.* the greater *Segment* 6180, be ſet from *a.* upon each middle Line to croſs *b. c. d. e*, and *h. g. f. l*, by each two Points, *viz. b. e. c. d,* and *f. h,* and *l. g,* &c. draw ſtreight Lines croſſing each other at right Angles round about the Cube, ſo ſhall you have eight *Equilateral* Triangles, ſuch as are 2. 3. 4, and 5. 6. 7, *&c.* by which every corner being cut off, their will remain ſix Squares, as *b. c. d. e, g. h. f. l, k. l. m. n,* and eight Sexangles; then ſhall *b. d,* be the Baſe, and the Point *g,* of the next Square the Vertex to cut out the Triangle *b. d. g,* and *g. i,* ſhall be the Baſe, and K, the Vertex to cut out the Triangle *g. i. k,* and *K* in the Baſe and *b,* the Vertex to cut out *K. m. b,* and theſe three being cut, will leave a fourth Triangle between them *K. b. g*; and ſo of the reſt till you find the Body come forth.

The Body being thus prepared, let the Angle C, of the *Horizontal A. b.* C, *South,* then ſhall *A. b. d,* be a direct *North* Reclining 48 deg. 11 min. and the oppoſite Inclining as much, *A* C. *E.* and C. *b. f.* are two *South* Reclining as much, but Declining 60 deg. The other ſix *Conterminous* with the three do all Recline alike 19.28, whereof the two *South g.* C. *E.* and *g. c. f.* do alſo Decline 22.14, the two backward *Northern* Planes *K. b. d.* and *n. A. d.* do decline 37 deg. 45 min. and the two intermediate *North* Planes *b. K. f.* and *A. n. E.* do alſo decline 82.14, and as theſe do, ſo doth their oppoſites decline, and recline as much. Theſe Things being conſidered, and the Body being prepared, the *North* reclining Dial 48 deg. 11 min. is made according to the foregoing *Chapters*.

Here followeth a *Table* of all the *Hour* diſtances of all the Planes belonging to this Body, with the Requiſites of the reclining declining *Planes*.

North Reclining. 48 11 *Stiles height* 86 39			
Hours		*Hours diſtances*	
12		0	0
11	1	14	59
10	2	29	57
9	3	44	57
8	4	59	57
7	5	74	59
6	6	90	00

South Reclining 48 11 *Declining* 60 00			
Hours		*Hours on the Plane.*	
4	8	68	13
5	7	40	48
6	6	25	17
7	5	15	32
8	4	08	25
9	3	02	26
Sub-		ſtile.	
10	2	03	14
11	1	09	19
12	12	16	42
1	11	27	00
2	10	43	45
3	9	73	16

South Reclining 22 14 *Declining* 22 14			
Hours		*Hours on the Plane.*	
5	7	66	58
6	6	35	8
7	5	20	37
8	4	12	30
9	3	6	53
10	2	2	19
Sub-		ſtile.	
11	1	1	56
12	12	6	27
1	11	11	55
2	10	19	44
3	9	33	22
4	8	63	1

North Reclining 19 28 *Declining* 82 14			
Hours		*Hour di.*	
12		71	17
11	1	40	42
10	2	24	38
9	3	15	6
8	4	8	23
7	5	2	53
Sub-		ſtile.	
6	6	2	15
5	7	7	40
4	8	14	10
3	9	23	13
2	10	38	8
1	11	66	26

North Reclining 19 28 *Declining* 37 54			
Hours		*Hour di.*	
2	10	58	44
1	11	56	44
12	12	48	2
11	1	33	2
10	2	20	22
9	3	8	41
Sub-		ſtile.	
8	4	2	14
7	5	13	19
6	6	25	17
5	7	38	56
4	8	55	00
3	9	73	46

The other two *South* recline as much, and decline alſo 60 deg. *viz. b. e. f.* and *A. C. E.* have the ſame *Dials* ſerving for both, changing the Poſition of the *Subſtile*, and *Hours* as afore directed;

The *Requiſites* for this *Plane* are as followeth,

The Plane's Declination is ---- —	48.11
The Declination *Eaſt* and *Weſt* ——	60.00
The Diſt. of the *Meridian* and *Horizon*	37.45
The Subſtiles diſtance from the *Meridian*	16.41
The Plane's Longitude ---- ——	38.32
The Stiles height —— ——	22.06

This *Dial* is to be made by the Rules of the XVth *Chapter*.

The *Requiſites* of two *South* reclining 19.28. *viz. g. C. f.* and *g. C. E.* do alſo decline 22.14. and are to be made by the Rules of the XIIth *Chapter*.

g. f. C. and *g. E.* C. *South* Reclining --	19.28
Declining *Eaſt* and *Weſt* —— ——	22.14
The diſtance of the *Meridian* and *Horizon*	82.14
The *Subſtiles* diſtance from the *Meridian*	06.26
The *Plane's Longitude* ——	21.49
The *Stiles* height —— —	16.22

The Requiſites of the two middle *Planes*, *North* reclining as much, and do alſo decline 82.14, and are to be made by the Rules of the XVIIIth *Chapter*.

A *North* reclining —— —	19.28
Declining *Eaſt* and *Weſt* ——	82.14
The diſtance of the *Meridian* and *Horizon*	22.14
The Subſtiles diſtance from the *Meridian*	71.17

The

The Plane's Longitude	83.25
The Stiles height	19.53

The Requiſites of the other two *North* recliners as much, and do decline 37.54. and are to be made by the Rules of the XVIth *Chapter.*

A *North* Reclining	19.28
Declining *Eaſt* and *Weſt*	37.54
The diſtance of the *Meridian* and *Horizon*	75.31
The Subſtiles diſtance from the *Meridian*	48.02
The Plane's Longitude	56.45
The Stiles height	56.54

How to CUT

The Body of twelve Rhombs.

THE thirty firſt definition of *Euclid* defineth a *Rhomb*, to be a Parallelogram, or a Figure conſiſting of four equal ſides, but hath unequal Angles, as out of the Figure *a. b. c. d*, of this *Plane* may be compoſed two Bodies, one conſiſting of twelve *Rhombs*, as the Figure *a. b. c. k. b. n. d*, and the other of thirty *Rhombs*. To cut the Body of twelve *Rhombs*, make a Parallelpipped, as is *a. b. g. f*; let the length be 10000, as *a. b*, or *c. g*, the breadth and depth, as *f. b*, and *f. g*, be 7071, divide the Length into two equal parts, as *d.* L. 1. from thoſe Points draw Lines to the Angles, and they ſhall include four *Rhombs*, as are *m.* 1. *b. L*, and L. *p. d. R*, &c. Draw upon each end two *Diagonal* Lines, as *A. C,* and *B. e.* which joyning at each Angle with the Lines drawn from the middle Point, ſhall make Triangle ſuch as *A. L. C, &c.* Cut away each Corner by theſe Triangles, *viz. e.* by the Triangle *A. L. C*; and ſo of the reſt, ſo ſhall you at eight Cuts frame the Body of twelve *Rhombs*, as you ſee the *Figure* is.

The Body being prepared, ſet the Angle *c,* of the *Horizontal Rhombs a. b. c. d, South*, then will *f. h. g. o,* be a direct *South*, and his oppoſite a direct *North* Dial; the other are all declining a like; whereof the four uppermoſt do recline 30 deg. and oppoſites do incline as much; and each doth decline 54 deg. 44 min. *Eaſt* and *Weſt*; therefore any two *Dials* being made, will ſerve for all the reſt, except the *North*, *South*, and *Horizontal*.

b. a, and *a. d,* are *North* reclining 30 deg. and decline 54:44, and are made by the Rules of the XVth *Chapter*.

The diſtance of the *Meridian* and *Horizon*	54,44
The Subſtiles diſtance from the *Meridian*	80.47
The Stiles height ——— ———	44.37
The Plane's Longitude ———	83.30

The other two *Planes* as *b. c. f. e.* and *d.e.g.m.* are *South* reclining 30 deg. and declining *Eaſt* and *Weſt* 54.44. and are made by the Rules of the XVIth *Chapter*.

The diſtance of the *Meridian* from the *Hor.*	54 44
The Subſtiles diſtance from the *Meridian*	04.37
The Stiles height ——— ———	04.36
The Planes Longitude ——— ———	45.11

North Reclining 30				*South Reclining* 30			
Hours.		*Hours diſtance.*		*Hours.*		*Hours diſtance.*	
12		80	48	2	10	32	04
11	1	60	44	1	11	11	05
10	2	43	31	12	12	06	01
9	3	29	12	11	1	03	33
8	4	16	59	10	2	01	55
7	5	06	00	9	3	00	37
Sub-		ſtile.		Sub-		ſtile.	
6	6	04	34	8	4	01	13
5	7	15	27	7	5	02	38
4	8	27	28	6	6	04	34
3	9	41	26	5	7	07	52
2	10	58	14	4	8	16	31
1	11	77	59	3	9	87	43

To CUT the

Body compoſed of 30 *Rhombs.*

THIS *Body* is repreſented by the *Figure* L. Z. A. E. and is ſomewhat more troubleſome to cut than the former, and is framed out of a Cube, as *a m g k* dividing every ſide by extream and mean Proportion, which is thus eaſily done; Let *a b. b g. b m. &c.* be 10000, then ſhall *a c. b d. b n. m h. b f. g e, &c.* be 6180, the greater *Segment*, which taken of a *Sector* opened to the wideſt of any one ſide, and ſet from each Angle *a b. g m, &c.* both ways, ſhall leave *a d. b c. b h. m n. b e. g f. &c.* 3810, the leſſer *ſegment* of the ſame ſides, from the terms of the greater *ſegment* on the one ſide, to the leſſer on the other ſide, draw Parallel Lines, as *d e. a f. b g.* and *q i.* croſs them with the like Parallel Lines as are *c b. b q. e k.* and *f p.* from each oppoſite Angle *b k.* and *a g.* unto the Leſſer *ſegment* oppoſite to the ſaid *Angles*, draw Parallel Lines, as are *a p. g c. b i.* and *k d*; ſo ſhall you have all the Lines on this ſide the Cube neceſſary for direction in cutting this Body; and thus muſt you do with all the reſt of the ſides: the Line being drawn as you ſee in the *Figure*, there is three Triangles framed about every ſolid *Angle*, as are the Lines *a f b. m d e.* and *g n c.* about the Angle *b*, by which the *Angle* muſt be three times cut, continuing each Line as a part is cut away, to avoid Confuſion, ſo ſhall you at twenty four cuts produce the Body of 30 *Rhombs* deſired; which being prepared, ſet the acute *Angle* N, of the *Horizontal Rhombs* M N R L, *South*, then ſhall the *Rhomb* O P Q K, be a direct *South Dial*, and his oppoſite a *North*, A B C D. of the Cube (being the ſame in the Body) *Weſt*, and his oppoſite an *Eaſt* Plane; the reſt are all *South* and *North* declining and reclining, as are the three *Rhombs* O P N T, T N R X, and T X Z O, which are conterminous with the *Horizontal*, and *South*, and *Weſt* Planes. do decline

cline and recline, ſo do all the reſt, as from the very inſpection of the *Figure* of the Body doth ſufficiently appear: Wherefore having found the declination and reclination of theſe three Planes, there is as much done as is uſefull for the Body; then will you find that *OPNT*, and *KPNC*, will be two reclining 30 deg: and declining *Eaſt* and *Weſt* 20 deg. 54 min. and *TNRX*, and *CMND*, will be *South* reclining 54 deg. and declining 56 deg. 16 min. and *OTXZ*, and *KCDE*, *South* reclining 18 deg. ond declining *eaſt* and *weſt* 58:16. the three *North* ones will be the ſame with the *South* in all reſpects, both for reclination and declination; by which means you may have twenty four reclining declining *Dials*, whereof three will be *South* reclining declining *Eaſt*, and three will have the ſame declination *Weſt*, and will decline the ſame, and ſo their will be of the *North* reclining declining *Dials*, and each hath his oppoſite, which recline, and decline as much, and their will be five ordinary *Dials*, *viz.* a *Horizontal*, a *South*, a *North*, an *Eaſt* and *Weſt*, ſo will you have twenty nine *Dials* on this Body. *The* manner of making theſe *Dials* is ſhewed in the foregoing *Chapter*. *The* Requiſites and hour *Arches* on their Planes are as followeth.

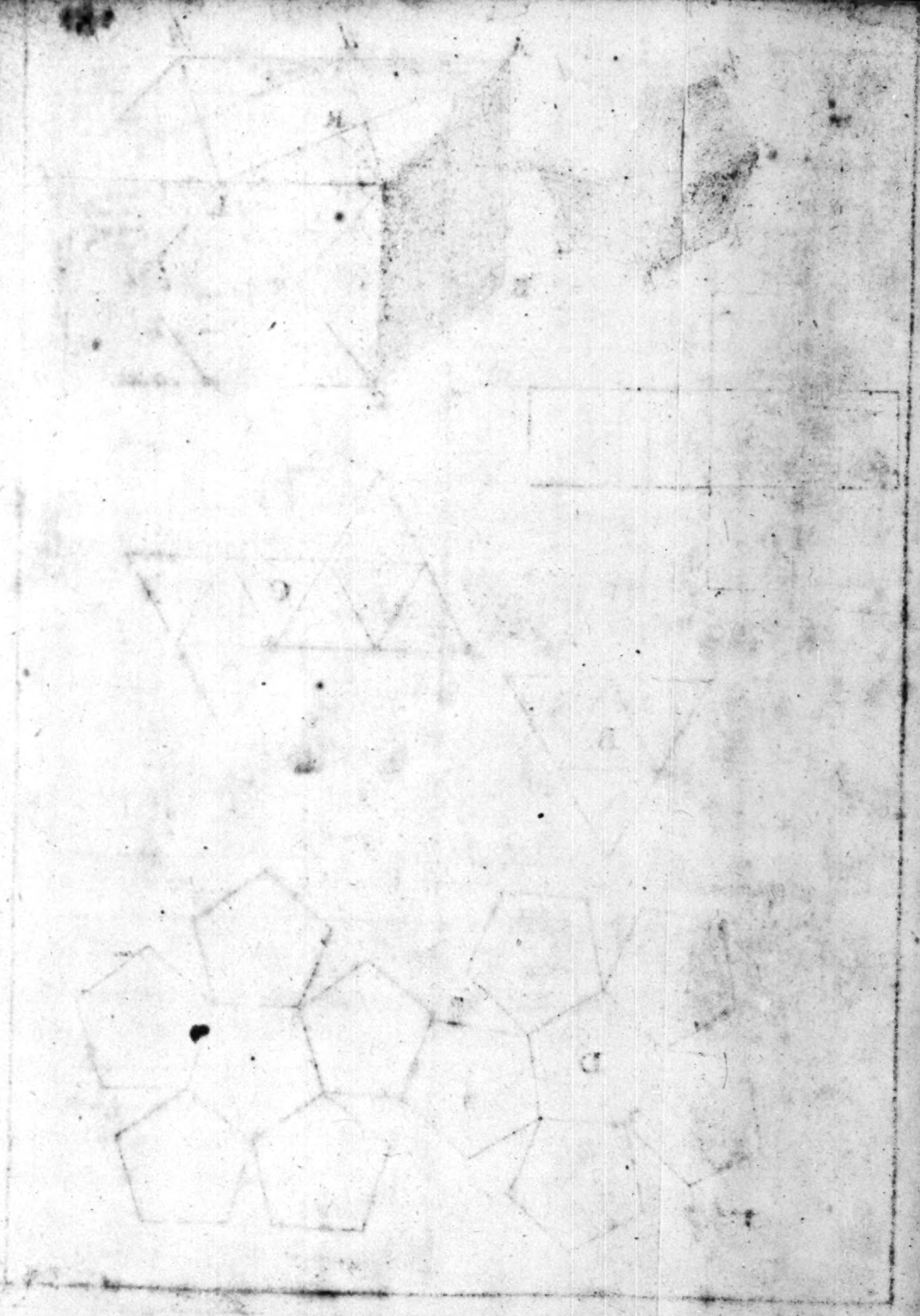
South Reclining		30. 00		South Reclining		54. 00		South Reclining		18. 00	
Declin		20. 54.		Declin.		56.16		Declin.		58.16	
Hours		Hours distan		Hours		Hours distan.		Hours		Hours distan.	
5	7	64	2	4	8	81	17	3	9	23	7
6		18	52	5	7	52	14	4	8	8	44
7	5	9	43	6	6	33	9	5	7	4	51
8	4	5	43	7	5	21	4	6		2	52
9	3	3	15	8	4	12	13	7	5	1	30
10	2	1	21	9	3	4	58	8	4	0	24
Sub-		Stile.		Sub-		Stile.		Sub-		Stile.	
11	1	0	21	10	2	1	42	9	3	0	38
12		2	6	11	1	8	34	10	2	1	47
1	11	4	10	12		16	30	11	1	3	13
2	10	7	6	1	11	26	48	12		5	28
3	9	12	26	2	10	47	58	1	11	10	18
4	8	27	59	3	9	65	58	2	10	34	11

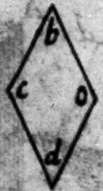
South Reclining	30	00
Declining *East* and *West*	20	54
The diſtance of the *Mer.* and *Horizon*	79	11
The Subſtiles diſtance from the *Meridian*	02	5
The Stiles height	06	25
The Planes Longitude	18	7

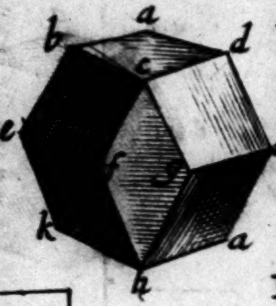
Therefore the Subſtile ſtands between 10 and 11 in the *East* Dial, and between 1 and 2 in the *West* Dial. And made by the Rules of the 12*th* Chapter.

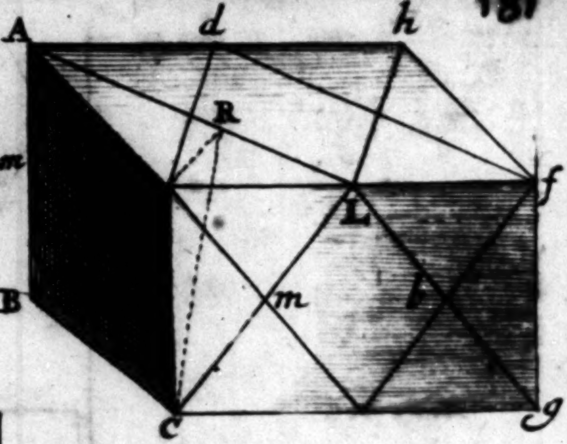
South Reclining ———— 54 00

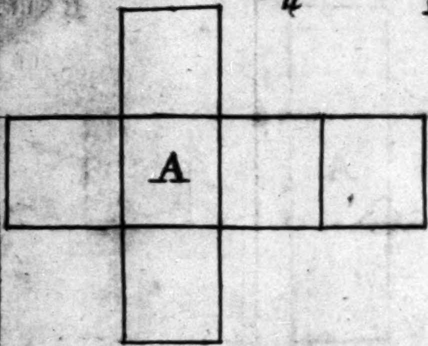
Decli-

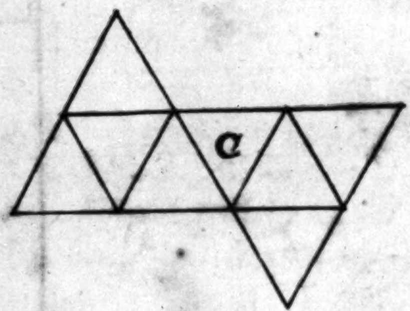


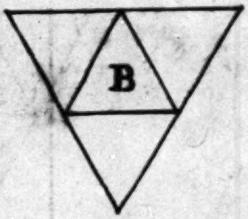


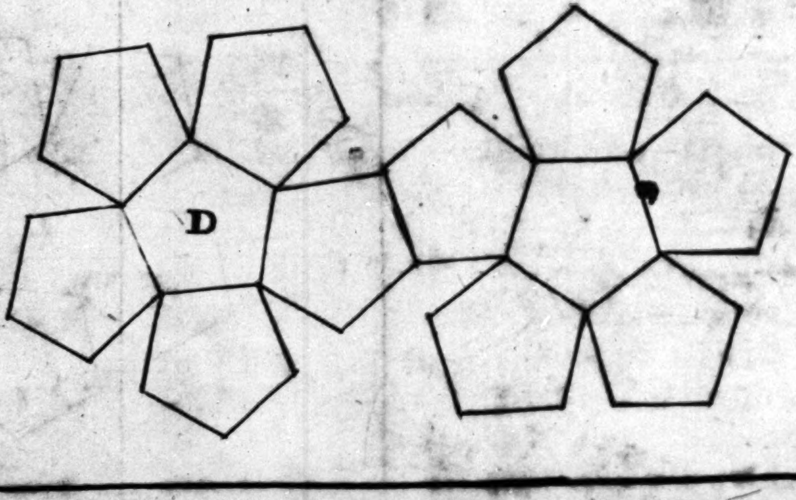












EV

Declining *Eaſt* and *Weſt*	56	16
The diſtance of the *Meridian* and *Horizon*	37	22
The Subſtiles diſtance from the *Meridian*	16	29
The Stiles height	26	10
The Planes Longitude	33	51

By which means the Subſtile falls between 9, and 10, in the *Eaſt*, and between 2 and 3 in the *Weſt* Recliner. And made by the Rules of the XV. Chapter.

South Reclining	18	00
Declining *Eaſt* and *Weſt*	58	16
The diſtance of the *Meridian* and *Horizon*	63	26
The Subſtiles diſtance from the *Meridian*	65	28
The Stiles height	03	57
The Planes Longitude	54	11

By which means the Subſtile will fall between 8 and 9, in the *Eaſt*, and between 3 and 4, in the *Weſt* Decliner. And made by the Rules of the 12*th* Chapter.

The Cutting of the five Regular Bodies in Paſt-Board.

1. THE Cube is compoſed of ſix Geometrical Squares, as *A*.

2. The *Tetrahedrum* is compoſed of three Equilatrial Triangles, as *B*.

3. The *Octohedrum* is compoſed of ſix Equilatrial Triangles, as C.

4. The *Dodecahedrum* is compoſed of twelve Equilatrial Pendegons, whoſe ſides are equal, and the Angles 72 deg. as *D*.

5. The *Icoſhedrum* is compoſed of twenty Equilatrial Triangles, as *E*.

Theſe Bodies being ſo cut will fold up, and appear as the ſolid Bodies.

North

North Reclining 30 00 Declin. 20.54		North Reclining 54.00 Declin. 58.16		North Reclining 18. 00 Declin. 58.16	
Hours	Hours diſtan.	Hours	Hours diſtan.	Hours	Hours diſtan-
4 8	74 40	2 10	87 5	1 11	87 54
5 7	58 27	3 9	69 13	2 10	62 20
6	43 2	4 8	52 27	3 9	42 26
7 5	28 29	5 7	37 12	4 8	27 58
8 4	14 35	6	23 20	5 7	16 56
9 3	1 5	7 5	10 27	6 6	7 45
Sub-	ſtile.	Sub-	ſtile.	Sub-	ſtile.
10 2	12 23	8 4	1 59	7 5	0 39
11 1	26 11	9 3	14 31	8 4	9 6
12	40 37	10 2	27 46	9 3	18 30
1 11	55 53	11 1	41 56	10 2	29 56
2 10	72 00	12	57 40	11 1	45 8
3 09	88 38	1 11	74 52	12	66 59

North Reclining ——	30 00
Declining *Eaſt* and *Weſt*, ——	20 54
The diſtance of the *Meridian* and *Horizon*	79 11
The Subſtiles diſtance from the *Meridian*	40 36
The Stiles Height ——	63 28
The Planes Longitude ——	43 47

This *Dial* is made by the Rules of the 16*th* Chapter.

The *North* Reclining —— —	54.00
Declining *Eaſt* and *Weſt* ——	58.16
The diſtance of the *Meridian* and *Horizon*	37.22

The

The Subſtiles diſtance from the *Meridian*	57.40
The Stiles height	55.39
The Planes Longitude	62.24

This *Dial* is made by the Rules of the XVIII *Chapter.*

The North Reclining	18.00
Declining *Eaſt* and *Weſt*	58.16
The diſtance of the *Meridian* and *Horizon*	63.26
The Subſtiles diſtance from the *Meridian*	65.59
The Stiles Height	33.34
The Planes Longitude	76.11

This *Dial* is made by the Rules of the XVI *Chapter.*

And thus you have all the *Tables* and *Requiſites* belonging to all the Bodies mentioned in this Book. *Note*, That upon all *South* reclining declining Dials, the declination of the *Meridian* or Planes Longitude, is accounted from the Noon *Meridian:* And upon all *North* declining reclining Dials, leſs than a Polar Dial, the Planes Longitude is reckoned from the Midnight *Meridian*, or twelve a Clock at Night, and in all Polar Dials it may be accounted from either Noon, or Midnight, becauſe the Longitude of the Plane is always 90 deg. and in all *North* declining reclining Dials, more than a Polar, it is found from the Midnight *Meridian*, but the Complement to 180 deg. is the difference of Longitude, from the *South*, ſee Page 122.

You have in *Figure* 36, a Dial which ſheweth by the ſhade of the Stile, what People, whether by Sea or Land, have the Sun juſt over their Heads at ſuch a time as you look upon the Dial; which is performed by inverting that part of the *Teriſtrial Globe*, which is included between the two *Tropicks*.

The Reaſon of this Inverſion is, that the ſhadow the Stile being always caſt towards to contrary part to the Sun, that is, if the Sun be *Eaſt*, his ſhade falls towards the *Weſt*, *&c.* therefore is it neceſſary that the *Eaſtern* part of the World ſhould lie *Weſtward*, and the *Northern* part *Southward*.

These Dials are beſt to be *Equinoctial* ones, on which this ſort of Furniture is diſcribed, for it appears the beſt on theſe ſort of Planes: The making of an *Equinoctial* is taught in *Page* 20, and this Furniture deſcribed after this manner; Your Dial being made, and a *Trigon*, as in *Page* 135, put into your *Trigon* (beſides the *Tropicks* and *Equinoctial*) 5, 10, 15, and 20 deg. of Declination, for that anſwereth on this Dial, for 5, 10, 15, and 20 deg. of Latitude from the *Equinoctial*, and transfer them (in obſcure Lines) from your *Trigon* to your *Plane*; this being done, your *Perpendcular Stile* being made *Radius*, ſet the *Tangent* of 5, 10, 15, and 20, from the twelve a Clock Hour-Line, and draw obſcure Lines thro' the Points parallel to the twelve a Clock, and they ſhall repreſent your Longitude, your Dial is ready for to deſcribe your Furniture; then take a Map of the Place you deſire to draw on your Dial, and turn the bottom upward, and deſcribe the Country, according to its Latitude and Longitude, and your Work is done.